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STUDIES IN ARTOCARPUS AND ALLIED GENERA, III. A REVISION OF ARTOCARPUS SUBGENUS ARTOCARPUS *

FRANCES M. JARRETT

Series **Cauliflori** Jarrett, ser. nov.

Folia simplicia, adulta integra, juvenilia ad 5-lobata; hypodermis et cellae resinosae absentes (hic in ceteris speciebus subg. *Artocarpi* inventae); glandulae immersae capitibus globosis 6–10-cellis. *Inflorescentiae* trunco et ramis, masculae etiam ramulis, latae. *Capitula mascula* superficie plana, floribus fertilibus vel paucis sterilibus solidis obtecta, omnibus aequalibus, bracteis absentibus. *Syncarpia* processibus puberulentibus ad minute hispidis, omnibus aequalibus obtecta, bracteis absentibus; semina testis tenuis, brunneis, pericarpiis membranaceis (*A. integer*) vel endocarpiis corneis et exocarpiis subgelatinosis (*A. heterophyllus*), perianthiisque crassis, carnosis inclusa.

TYPE SPECIES: *Artocarpus integer* (Thunb.) Merr.

In a paper entitled "Notes on the systematy and distribution of Malayan phanerogams, II. The Jack and the Chempedak," Corner discussed in detail the nomenclature and distinguishing characters of the two species included in this series (Gard. Bull. Singapore **10**: 56–81. *t. 1, 2.* 1939). The descriptions given below are based in part on this paper. The nomenclatural studies are reviewed above (pp. 119–122). They showed that the name *Artocarpus integer* (Thunb.) Merr. (*Rademachia integra* Thunb.), with its illegitimate synonym *A. integrifolia* Linn. f., should have been applied to the Chempedak, rather than to the Jack, as had been the universal practice since the beginning of the nineteenth century. *Artocarpus heterophyllus* Lamarck was then chosen by Corner as the correct name for the Jack.

A detailed analysis was given by Corner of the distinctions between *Artocarpus integer* (including var. *silvestris*) and *A. heterophyllus*, and the chief characters are enumerated below. The variety of the latter which is said to resemble *A. integer* is excluded from consideration here. Vegetatively, *A. integer* and *A. heterophyllus* are differentiated by the colour (when fresh) and the shape of the leaf blade (the base being abrupt in the

* Continued from volume XL, p. 326.

former and decurrent onto the petiole in the latter) and by the frequently hirsute versus subglabrous shoots.

The inflorescences in *Artocarpus integer* are somewhat smaller in all their parts than in *A. heterophyllus*, and in the latter alone the top of the peduncle is expanded to form a narrow fleshy flange or annulus at the base of the male and female heads. The syncarp in *A. integer* becomes characteristically "baggy" at maturity, due to the separation of the wall from the free, fleshy region of the fruiting perianths. The perianths also become detached from the core, so that they fall out when the syncarp is cut open. This separation does not occur in *A. heterophyllus* and the edible fruiting perianths must be cut away from the rest of the syncarp. There are considerable differences in the details of the fruiting perianths and of the enclosed structures in the two species. In *A. integer* the ripe, free, hypertrophied region of the perianth is soft, without a stalk, and the enclosed pericarp is membranous with the style attached one-third of the way up the ventral face. The embryo has somewhat unequal cotyledons and the radicle is immersed between their short basal lobes. In *A. heterophyllus* the fruiting perianths are firm with a fleshy, thickened stalk. The pericarp is clearly differentiated into a subgelatinous exocarp, 1 mm. thick (which apparently persists until the decay of the syncarp), with the style attached two-thirds the distance up its ventral face, and a horny endocarp [8] which becomes completely free from the exocarp at maturity. The embryo has very unequal cotyledons and the radicle is superficial, being well developed and directed down towards the hilum. Figures illustrating these various differences are given in Corner's paper.[9]

The characters of greatest taxonomic significance in distinguishing the species are probably those provided by the pericarps and embryos and the presence or absence of the annulus. The presence of a well-developed endocarp in *A. heterophyllus* but not in *A. integer* is especially noteworthy. The difference in the embryos is considerable, but it is difficult to determine its significance in view of the lack of complete information for section *Artocarpus* and the variation which is found in the other series. The annulus is likewise difficult to evaluate as a taxonomic character since it is developed only in *A. heterophyllus*. It is presumably equivalent morphologically to the slight expansion of the peduncle at the base of the inflorescence head that is found in various other species of *Artocarpus*, and perhaps also to the basal involucre in *Parartocarpus*. Although the cumulative effect of these differences is to make the two species rather distinct from each other, none of them is, in itself, sufficient to justify the creation of a separate series for each species, with the possible exception of the endocarp character.

On the other hand, the characters uniting *Artocarpus integer* and *A. heterophyllus* are equally marked, as is pointed out in the discussion of section *Artocarpus* (p. 131 above). Nevertheless, none of these — namely,

[8] Referred to as the outer testa on p. 128 above, and by Corner.

[9] TEXT-FIGURES 3 and 4 were accidentally transposed; the legend on p. 66 refers to the figure on p. 67 and *vice versa*.

cauliflory and the very large size of the syncarps, the hypertrophied fruiting perianths, the lack of resin-cells in the leaves and perhaps the separation of the cotyledons to allow the emergence of the plumule in germination — is again sufficient to warrant the placing of the species in a separate section. In the shape of the inflorescences, the position of the style and the orientation of the embryo, the general alliances of series *Cauliflori* are with the other members of sect. *Artocarpus*, and the group is perhaps nearest to series *Angusticarpi*.

14. **Artocarpus integer** (Thunb.) Merr. Interpr. Rumph. Herb. Amb. 190. 1917, non sensu Merrill; Corner, Gard. Bull. Singapore **10**: 56. *t. 1, 2.* 1939.

Saccus arboreus minor Rumph. Herb. Amb. **1**: 107. *t. 31.* 1741.

Rademachia integra Thunb. Vet. Akad. Handl. Stockholm **37**: 254. 1776; Houttuyn, Nat. Hist. II. Pl. **11**: 453. 1779. Holotype, Java, *Thunberg s.n.* (UPS, photograph in Corner, 1939); ? isotype (L).

Sitodium macrocarpon Thunb. Philos. Trans. Roy. Soc. London **69**: 467. 1779, nomen illegitimum.

Artocarpus integrifolia Linn. f. Suppl. Pl. 411. 1781, nomen illegitimum; Panzer, Beitr. Geschichte Brodbaums, 35. 1783, et in Panzer & Christmann, Pflanzensyst. **10**: 371. 1783; Murray, Syst. Veg. ed. 14. 838. 1784; Persoon, Syst. Veg. ed. 15. 882. 1797.

Sitodium cauliflorum Gaertn. Fruct. **1**: 345. 1788, nomen illegitimum.

Artocarpus jaca Lamarck, Encycl. Méth. **3**: 209. 1789.

Artocarpus pilosus Noronha, Verh. Batavia. Genoot. **5**(5): 7. 1790, nomen nudum.

Polyphema champeden Lour. Fl. Cochinch. 546. 1790, pro maxima parte, "spathis" exclusis.

Artocarpus polyphema Persoon, Syn. Pl. **2**: 531. 1807, nomen illegitimum.

Artocarpus champeden (Lour.) Stokes, Bot. Mat. Med. **4**: 330. 1812; Sprengel, Syst. Veg. **3**: 804. 1826.

Artocarpus pilosa Reinw. ex Blume, Cat. Bog. 101. 1823, nomen nudum.

Artocarpus hirsutissima Kurz, Natuurk. Tijdschr. Ned. Ind. **27**: 182. 1864. Holotype, Bangka, *Kurz 1017* (CAL); isotype (CAL).

var. **integer**

Evergreen trees, height to 20 m., not or scarcely buttressed, bark greyish brown, somewhat scaly. *Twigs* 2.5–4 mm. thick, shallowly rugose or smooth, pilose with sparse to dense, patent, rufous hairs to 3 mm. long, often also with shorter, whitish hairs; annulate stipular scars c. 0.5 mm. across, not or slightly prominent; lenticels scattered. *Stipules* 1.5–9 cm. long, ovate, acute, indumentum as twigs. *Leaves* 5–25 × 2.5–12 cm., obovate-elliptic, varying obovate- or elliptic-oblong or elliptic, acuminate, base cuneate or rounded, abrupt, margin entire; juvenile leaves elongate, or with 1–2 pairs lateral lobes; main veins only prominent beneath, or intercostals slightly so; main veins pilose beneath or on both surfaces, lower surface often appressed-pubescent throughout, rarely also above, the hairs rufous; lateral veins 6–10 pairs, curved; intercostals few, to c. 10, parallel, markedly oblique; dull mid-green, midrib pale, drying red-brown; hypo-

dermis absent; gland-hairs deeply immersed in pits contracted at the mouth, heads globose, c. 10-celled; petiole 8–30 mm. long.

Inflorescences solitary in leaf-axils; cauliflorous and ramiflorous, flowering on short leafy shoots; male heads sometimes borne on the ultimate twigs. *At anthesis*: *male head* 30–55 × 9–12 mm., cylindric, varying clavate, smooth, covered by flowers; perianths tubular, 0.7–1.0 mm. long, very shortly bilobed above, minutely pubescent; stamen 1.0–1.3 mm. long, filament cylindric, anther-cells ellipsoid, 0.25 mm. long; peduncle 25–60 × 1.5–3 mm., indumentum as twigs; *female head* with simple, filiform styles exserted to 1.5 mm. *Syncarp* 20–35 × 10–15 cm., cylindric, somewhat "baggy" at maturity, yellow, drying brown, with a strong, harsh, penetrating odour (like durian and *Mangifera foetida*), covered by closely set, firm, tapering, obtuse, minutely hispid processes, 2–4 × 3 mm.; wall c. 10 mm. thick; fruiting perianths numerous, proximal free region yellow, markedly fleshy, soft, becoming detached from wall and core, "seeds" (membranous pericarps) ellipsoid to oblong, c. 30 × 20 mm., style one-third the distance up the ventral face, testa thin, embryo with the radicle ventral, immersed, enclosed by the basal lobes of the cotyledons, these oblique to the median plane of the ovary, unequal, one cotyledon two-thirds to three-quarters the length of the other; peduncle 55–65(–90) × 4–7 mm., indumentum as twigs.

VERNACULAR NAMES: *Sone-ka-dat*, Moulmein, Burma; *Chempedak*, *Tjempadak*, *Champada*, *Tjampada* and variants (Malay), peninsular Siam, Malaysia. USES: the fleshy perianths, "with a strong, sweet taste of durian and mango," which surround the seeds are eaten and the flavour is considered superior to the Jackfruit; the seeds are also eaten roasted or boiled.

DISTRIBUTION: Apparently indigenous in evergreen forest to 1500(–4000) ft., Sumatra, Borneo, Celebes, Moluccas, New Guinea (Vogelkop); cultivated in Tenasserim (Moulmein), and throughout Malaysia, except central and eastern Java, the Philippines and eastern New Guinea; restricted both when indigenous and cultivated to regions without a marked dry season.

Sumatra. ATJEH. Gunong Caoutchouc, Langsa, *bb 2574* (BO, L). TAPANULI. Barus, Pankalan Tapus, *bb 28454* (BO, L, SING); Padang Lawas, Batang Baruhar, *bb 6442* (BO); Padang Lawas, Purbasinamba, *bb 6201* (BO, ♀). WEST COAST. Padang Pandjang, near Pajakumbuh, *Meijer 7116* (L); Sidjundjung, Muaro, *bb 9064* (BO, L); Solok, Sulangko, Gunong Batu Kunit, *Koorders 10666* (BO). EAST COAST. P. Berhala, *Lörzing 6989* (BO, L, ♀). INDRAGIRI. Damar Mengkuang, *bb 27539* (BO); Kwala Belilas, *bb 27594*, *27606* (BO). PALEMBANG. Banjuasin and Kubustreken, Banjunglintjir, *NIFS T 54* (BO, L, ♀); Lematang Ilir, Semangus, *bb 31736* (BO, L), *32006* (BO); Rawas, *Grashoff 1026* (BO).

Borneo. BRUNEI. Mile 3, Kuala Abang road, *Ashton BRUN 85* (L, ♀). EAST AND NORTHEAST BORNEO. E. Kutei: Tandjong Bangko, near Mahakam River estuary, *Kostermans 7091* (L, ♀). W. Kutei: Longbleh, *bb 16081*, *16120* (BO); Mujup, *bb 16733* (BO), *16754* (A, BO, SING). BRITISH NORTH BORNEO. Beaufort, Lumat, *Cuadra A 1334* (SING).

Celebes. CENTRAL CELEBES. Malili, Usu, *NIFS Cel./III–70* (BO, ♂, ♀), *127*

(BO), *128* (A, BO, SING), *129*, *130* (BO). P. MUNA. Wapai, *bb 21731* (A, BO). **Moluccas.** SULA ISLANDS. Sanana, Kabauw, *bb 28869* (BO, L, SING). AMBON. Pula, Hatu, *bb 14268* (BO). **New Guinea.** VOGELKOP. Kali Kamundan, *bb 21882* (BO, ♀); Manokwari, Sidai, *Schram BW 1741* (L); Tavui, *bb 22318* (A, BO, L, ♀).

var. **silvestris** Corner, Gard. Bull. Singapore 10: 76. 1939. Holotype, Malaya, *Corner SFN 32988* (SING).

Differs from var. *integer* as follows: twigs, leaves and peduncles varying to entirely glabrous; *leaves* withering green, yellowish green or dingy yellow, not rich ochre or orange, drying blackish brown to red-brown; *syncarp* 15–30 × 10–15 cm., without any odour; fruiting perianths more or less tasteless.

VERNACULAR NAMES: *Bankong*, Malaya; *Barok*, Johore, Lingga Archipelago.

DISTRIBUTION: Malaya, Sumatra, Lingga Archipelago, Borneo.

Siam. PENINSULAR SIAM. Patalung, Kao Soi Dao, *Kerr 19234* (BM, ♀); Pattani, Banang Sta, *Kerr 7422* (BM, ♀). **Malaya.** PERAK. Tapah, *Wray 1356* (K, SING, ♂, ♀). PAHANG. Raub, Batu Talam, *Burkill & Haniff SFN 17030* (SING, ♀); Fraser's Hill, *Corner SFN 33205* (SING, ♂), *Corner s.n.*, Aug. 1937 (SING), *Nur SFN 11254* (BO, SING, ♀), *Strugnell CF 14627* (SING, ♀); Kuala Teku, *Corner SFN 33688* (SING, ♀); Sungei Tahan, *Corner s.n.*, Sept. 1937 (SING), *Ridley s.n.*, June 1891 (SING, ♀). SELANGOR. Kuala Lumpur, Weld Hills Res., *Ahmad CF 4586* (SING, ♀); Simpang mines, *Ridley s.n.*, Aug. 1904 (SING). JOHORE. Mawai-Jemalaung road, Sungei Kayu, *Kiah s.n.*, Oct. 1936 (SING); 18th mile, Mawai-Jemalaung road, *Corner SFN 32988*, May 1937 (SING, ♀). PENANG. *King 1636*, (CAL, SING, ♂). SINGAPORE. Changi, *Ridley 5028* (CAL, SING, ♀).

Sumatra. PALEMBANG. Lematang Ilir, Gunong Megang, *NIFS T 814* (BO, ♂, ♀). LINGGA ARCHIP. P. Sinkep: Djago, *bb 3943* (BO); Selewar, *bb 4067* (BO); Sungei Bajur, *bb 2072* (BO); Sungei Buluh, *bb 4081* (BO); Sungei Manggu, Muara Ketjil, *bb 3927* (BO); Sungei Pulak, *bb 4030* (BO); Tandjong Batang, *bb 4020* (BO); Tandjong Sembilang *bb 2047* (BO, L). **Borneo.** SOUTH AND SOUTH-EAST BORNEO. Tanah Bumbu, Kampong Baru, *bb 13374* (BO, ♂, ♀).

Artocarpus integer appears to be indigenous over a wide area in Malaysia, and all the collections cited above are recorded as having been made in primary or, less frequently, "old" forest. There is, however, some variation within the species, and in Malaya this was related by Corner in 1939 to the wild or cultivated status of the plant. Wild trees in Pahang and Johore were found to differ from the typical cultivated form of Malaya in the absence of odour from the syncarp and in the insipid fruiting perianths — both characters being in strong contrast to those of the cultivated Chempedak — and also in the lack of "autumn colours" in the withering leaves. Corner described these trees as *A. integer* var. *silvestris* and assigned to this entity all the specimens listed above from Malaya, with the exception of *Burkill & Haniff SFN 17030* and *Ridley 5028*, which were not cited. He also stated that, whereas the cultivated form was consistently pilose, the wild

trees varied to glabrous. The only entirely glabrous collections that have been seen are the type of var. *silvestris* (*Corner SFN 32988*) from Johore, *Ridley 5028* from Singapore, and the specimens listed above under var. *silvestris* from the Lingga Archipelago. These glabrous collections differ further from the others cited under var. *silvestris* in the rather small, elliptic leaves, which often dry a distinctive, blackish brown. The remaining collections cannot be distinguished with certainty on herbarium characters from the range of variation exhibited by var. *integer*, as represented by both cultivated trees and the wild specimens listed above. Furthermore, most collections of *Artocarpus integer* from eastern Malaysia (Celebes to New Guinea) are rather sparsely pilose. In addition to the collections from Malaya and the Lingga Archipelago, two collections from Siam are listed under var. *silvestris* on geographical grounds, as well as one each from Sumatra and Borneo which are stated to have inodorous fruits, although it must be pointed out that in both the female heads on the herbarium sheets were at anthesis. It is likely that var. *silvestris*, as defined by the inodorous, insipid fruits, is more widely distributed in Malaysia than is here indicated and further study of *Artocarpus integer*, both in the wild and in cultivation, is needed to elucidate the variation which it shows.

The male inflorescences of var. *silvestris* were described by Corner from his collection *SFN 33205*. The heads are conical, 3–4.5 × 2–2.5 cm., with a shallowly and irregularly rugose surface, perianths 1–1.5 mm. long and stamens 1.7–2.4 mm. long. There is no appearance of abnormality in the inflorescences, which have been seen preserved in spirit, but in all other collections of both varieties with male heads these are more or less cylindric, with a smooth surface.

As is indicated in the nomenclatural discussion at the beginning of the treatment of the genus *Artocarpus* (p. 122, above), there is some doubt as to the sources of Loureiro's description of *Polyphema champeden* which is here cited in synonymy under *Artocarpus integer*. It has generally been assumed that Loureiro's account was based on the Chempedak, and his name is the basionym of two names that have been used widely for this species, *Artocarpus champeden* (Lour.) Stokes and the illegitimate *A. polyphema* (Lour.) Persoon.

Loureiro stated that *Polyphema champeden* occurred in both Indochina and Malaya — "Habitat in altis sylvis Cochinchinae. Colitur etiam, & Champedèn vocantur a populis Malaiis circa fretum Malaccense habitantibus." — and he gave as synonyms "Champidaca. Bont. Jav. l. 6. cap. 31. pag. 119. Saccus arboreus minor: Tsjampadaha. Rumph. Amb. l. 1. cap. 26. tab. 31." However, *Artocarpus integer*, the Chempedak, is absent from Indochina, according to Gagnepain (in Lecomte, Fl. Gen. Indoch. 5: 734. 1928),[10] and this is confirmed by the material seen in herbaria, none of

[10] The records of *Artocarpus polyphema* from Indochina given by Lanessan (Pl. Utiles Colon. Fr. 742. 1886) and by Crevost and Lemarié (Cat. Prod. Indoch. 1: 266. 1917) were derived from Loureiro, although the second included information from another source, perhaps referring to varieties of the Jack (*A. heterophyllus*) that had been confused with the Chempedak.

which comes from farther north on the continent of Asia than peninsular Burma and Siam. Gagnepain also stated that Loureiro's plant did not correspond to any Indochinese species. Merrill accordingly concluded, in his commentary on the Flora Cochinchinensis (Trans. Am. Philos. Soc. 24(2): 135. 1935), that the description had been based on plants that Loureiro had seen near Malacca. He further stated that there was a type specimen in the British Museum (Natural History).

The question of the source of Loureiro's description of *Polyphema champeden* was discussed in some detail by Corner in 1939 (Gard. Bull. Singapore 10: 73). He stated that it had not been possible to find any type specimen and a further search in the herbarium of the British Museum (Natural History) has confirmed this. On the other hand, he showed that some phrases of Loureiro's description could be derived from Rumphius' account of *Saccus arboreus minor* and, since he felt certain that Loureiro had not seen any specimens from Malacca (see below), he concluded that the rest of the description must have been made from an undetermined Indochinese species, and that the name should be treated as a *mixtum compositum*. It is desirable that Loureiro's sources should be determined as exactly as possible, in order that the nomenclature of the species of *Artocarpus* from Indochina may have a secure basis.

In the course of this study it has been possible to examine the first reference cited under *Polyphema champeden*, which is to Piso's edition of Bontius' "Historiae Naturalis & Medicae Indiae Orientalis Libri Sex," published by the former in 1658 in his "De Indiae Utriusque Re Naturali et Medica." This shows that Loureiro also used the illustrations as a source for his description. As noted above under *Artocarpus communis* (p. 322), Bontius had apparently confused the Chempedak with the Breadfruit in his brief account of the latter and to this Piso added, under the erroneous name *Champidaca*, a drawing of a twig of *A. communis* bearing two syncarps and a pair of opposite, incised leaves below them. These are the source of Loureiro's puzzling "Spathae saepe repando-incisae." A re-examination of Rumphius' plate and description shows that rather more of Loureiro's account can be derived from them with some certainty than was assumed by Corner. An extension of his analysis of the description in the Flora Cochinchinensis is given below, with the various sources indicated, the Latin extracts in brackets from the "Herbarium Amboinense."

Sp. 2. POLYPHEMA CHAMPEDEN. α Cây Mít nai.

Differ. spec. Pol. foliis oblongis, integerrimis, pilosis, rugosis, sparsis [diagnosis derived from the following].

Hab., & notae. *Arbor supra mediocrem: trunco, & ramis rectis, ascendentibus.* Folia oblonga, sub-acuta, integerrima, venosa [Rumphius' illustration], rugosa, pilosa, superius obscuro-viridia, subtus flavescentia [rugosa & pilosa, . . . superius obscure virentia, inferius flava], sparsa, petiolis longis [Rumphius' illustration]. Spathae saepe repando-incisae [leaves of *Artocarpus communis* in Piso's illustration]. Amenta oblongo-ovato [? male head in Rumphius' illustration], scabra, flosculis propriis tecta, ut in Polyph. Jacâ. Baccae compositae vix pedem longae, 4 pollices latae, muricatae, flavo-virides [Fructus . . . pedem nempe modo longus, quatuor vel quinque crassus digitos . . . Exterior

flavo-viridis ac pilosus cortex obsessus quoque est angulosis & acuminatis tuberculis seu verruculis]: baccis partialibus plurimis, *ovatis, sub-angulatis*, flavis, humescentibus, parvis [nuclei . . . usque ad octuagenarium & centesimum numerum, quae obducuntur quoque succosa ac mucosa carne instar nucleorum, uti *Nanca*, nuclei hi autem multo sunt minores, caro etiam multo magis flava est, ac succosior, gratique saporis] edulibus, nimiâ dulcedine, & intenso odore parum gratis [? information from Malacca — this character is not made clear in Rumphius' account]. Tota arbor humore lactescente scatet [Rumphius in various places]. Fructus pendent ex summo trunco, & ramis pedunculis [fructus crassissimis ex ramis excrescunt uti quoque ex summo trunco propriis ex pedunculis] longis [? Rumphius' illustration].

The words in italics, referring to the habit of the tree and the shape of the fruiting perianths, and perhaps also the description of the "ament" (probably the male head), were apparently derived from personal observation and may have been based on the Indochinese species which Loureiro confused with the Chempedak. The identity of this cannot now be determined: the only species which is at all similar is the Jack, *Artocarpus heterophyllus*, but the variety somewhat resembling the Chempedak is not recorded from Indochina. The Annamese vernacular name *cay mit nai* is applied to the two other members of *Artocarpus* subg. *Artocarpus* occurring in the area. The major part of the description, including the diagnostic characters, was based on the Chempedak. Thus it seems justifiable to treat *Polyphema champeden* as a synonym of *Artocarpus integer*, although it is recognized that the description of the "spathes," and perhaps those of some other characters, were derived from different species.

Stress was laid by Corner on Loureiro's description of the hairs on the leaves of *Polyphema champeden* as sparse, and this supports his contention that Loureiro had not seen the cultivated Chempedak in Malaya, which is characterized by markedly pilose twigs, stipules and peduncles. Loureiro, on the contrary, stated in his comparison of *Polyphema* with *Artocarpus* (in a note under the first of his two species, *Polyphema jaca*) that in *Polyphema* the peduncles were always glabrous. This may be accounted for by this part of his description of *Polyphema champeden* apparently having been taken from Rumphius, who was describing the more sparsely hairy eastern Malaysian form of the Chempedak and who showed, in his illustration, scattered hairs on only one twig and pair of stipules.

15. **Artocarpus heterophyllus** Lamarck, Encycl. Méth. 3: 210. 1789, "*heterophylla*"; Corner, Gard. Bull. Singapore **10**: 56. 1939. Syntypes, Isle de France [Mauritius], *Commerson s.n.* (P-JU), *sine nom. et num.* [? Philippines, *Sonnerat*] (P-LA); lectotype, *Commerson s.n.* (P-JU).

Arbor pala, pomo ariena Pliny, Nat. Hist. lib. XII. cap. xii. circa A.D. 77, foliis exceptis.

Jaca Garcia da Orta, Coloquios, 110. 1563.

Iaca Acosta, Trata Drogas & Medicinas Indias, 264. 1576.

Iaacas Linschoten, Itinerario 1: 73. 1596.

Palma fructu aculeato ex arboris trunco prodeunte Bauhin, Pinax, 511. 1623.

Jaaca Bontius, De Medicina Indorum, 52. 1642.
Tsjaka-maram Rheede, Hort. Ind. Malab. 3: 17. *t. 26–28.* 1682.
Jaca Indica Ray, Hist. Pl. 2: 1440. 1688.
Nanca Kamel in Ray, Hist. Pl. 3, App. 52. 1704.
Saccus arboreus major Rumph. Herb. Amb. **1**: 104. *t. 30.* 1741.
Artocarpus philippensis Lamarck, Encycl. Méth. 3: 210. 1789. Holotype, *sine nom. et num.* [? Philippines, *Sonnerat*] (P-LA).
Artocarpus nanca Noronha, Verh. Batavia. Genoot. **5**(5): 7. 1790, nomen nudum.
Polyphema jaca Lour. Fl. Cochinch. 546. 1790. Holotype, Cochinchina (cult.), *Loureiro s.n.* (BM).
Artocarpus integrifolia Linn. f. *β heterophylla* Persoon, Syn. Pl. **2**: 531. 1807.
Artocarpus brasiliensis Gomez, Mem. Acad. Sci. Lisbon **3**, Mem. dos Corresp. 84. 1812.
Arctocarpus maxima Blanco, Fl. Filip. 669. 1837.
Artocarpus integrifolia mult. auct. non Linn. f.
Artocarpus integer mult. auct. non (Thunb.) Merr., sensu Merr. Interpr. Rumph. Herb. Amb. 190. 1917.

Evergreen trees, height to 10(–15) m., not or scarcely buttressed, bark greyish brown, somewhat scaly. *Twigs* 2–6 mm. thick, finely rugose to smooth, glabrous; annulate stipular scars c. 0.5 mm. broad, not or slightly prominent; lenticels none or scattered. *Stipules* 1.5–8 cm. long, acute, ovate, appressed-puberulent or glabrous. *Leaves* 5–25 × 3.5–12 cm., obovate-elliptic to elliptic, varying subrotund, obtuse to short-acuminate, base cuneate, decurrent, glabrous, margin entire; juvenile leaves elongate or with 1–2 pairs lateral lobes, slightly scabrid; main veins only prominent beneath or intercostals slightly so; lateral veins 6–10 pairs, curved; intercostals c. 10–14, parallel, oblique, nearly perpendicular to the midrib; dark green with pale main veins, drying greenish or pale brown, venation often straw-coloured; hypodermis absent; gland-hairs immersed, heads globose, c. 6-celled; petiole 8–25 mm. long.

Inflorescences solitary in leaf-axils; cauliflorous and ramiflorous, flowering on short leafy shoots; male heads sometimes borne on the ultimate twigs. *At anthesis*: *male head* 25–70 × 8–28 mm., narrowly clavate, rarely ellipsoid, smooth, covered by flowers, a few sterile, the perianths solid, not elongate; fertile flowers with perianths tubular, 1–1.5 mm. long, bilobed above, minutely pubescent; stamen 1.5–2 mm. long, filament cylindric, anther-cells ellipsoid, 0.3 mm. long; peduncle 12–55 × 1.5–2 mm., glabrous, expanded into a narrow flange or annulus 1.5–2.5 mm. wide at the base of the head; *female head* with simple, spathulate styles exserted to 1.5 mm. *Syncarp* 30–100 × 25–50 cm., cylindric or somewhat clavate, yellow, drying brown, with a sickly, sweet odour (like ripe bananas), covered by closely set, firm, tapering, obtuse, puberulent to minutely hispid processes, 4–10 × 4 mm.; wall c. 10 mm. thick; fruiting perianths numerous, proximal free region yellow, markedly fleshy, firm, with a thickened stalk, remaining attached to wall and core, "seeds" (separated horny endocarps enclosed by subgelatinous exocarps 1 mm. thick) oblong-ellipsoid, c. 30 × 15–20 mm., style two-thirds the distance up the ventral face, testa thin,

embryo with the radicle ventral, superficial, and the cotyledons almost transverse to the median plane of the ovary, very unequal, the upper cotyledon one-third to one-half the length of the lower; peduncle c. 50–100 × 8–10 mm., glabrous, expanded into a flange or annulus to 5 mm. wide at the base of the head (sometimes obscure at maturity).

VERNACULAR NAMES. (1) General: Jack, Jak, Jaquier, Jaca, etc. (2) India: *Panasa* (Sanskrit, Uriya, Telugu), peninsular India; *Phanas* (Marathi), Bombay; *Kanthal* (Hindi), *Kanthar* (Santali), northeastern India; *Halsu*, *Heb-halsu* (Kanarese), west coast; *Pila*, *Pilavu* (Malayalim, Telugu), Malabar and southern peninsular India; *Chakki*, general for the fruit; *Cos* (Sinhalese), Ceylon. (3) Southeastern Asia: *Peignai*, Burma; *Khanum*, Siam; *Knor prey*, Indochina; *Po-lo-mih*, *Po-lo-mat*, *Po-lo-shue*, China. (4) Malaysia: *Nangka*, as *Nongko* in Java, sometimes as *Langka* in the Philippines.

USES: The sweet, fleshy perianths enclosing the seeds are eaten, and the latter are also eaten roasted or boiled; the wood is highly valued for cabinet work and general house-building purposes; wood chips are used to provide a yellow dye.

DISTRIBUTION: Possibly indigenous in evergreen forest from 1500 to 4000 ft. on the Western Ghats of India; becoming naturalized sparingly in evergreen and semi-evergreen forest and tolerant of a dry season; cultivated throughout the tropics.

It is unlikely that the region within which *Artocarpus heterophyllus* was indigenous can now be determined, but it seems most likely that this was in India, probably along the Western Ghats. Wight (Ic. Ind. Or. 2: *t. 678.* 1843) made the general comment that the Jack appeared to be an indigenous plant in India. Beddome (For. Man. 219. 1873) recorded it from western mountain forests, and Gamble (Man. Ind. Timb. ed. 2. 653. 1902) and Talbot (For. Fl. Bombay 2: 527. 1911) stated definitely that they had seen it growing wild in rain forest on the Western Ghats, remote from human habitations. No collections annotated as having been made from such plants have been seen, but this is not surprising, since the species would be universally familiar.

The Jack may also be found apparently wild in evergreen and semi-evergreen forest in Assam and Burma, according to Kanjilal *et al.* (Fl. Assam 4: 268. 1940) and Brandis (Ind. Trees, 611. 1906), respectively. However, these authors state that it is always either on the site of deserted villages, or an escape from cultivation. In Ceylon, where the Jack is extremely common, it has always been regarded as an introduced plant.

The Jack has long been known from India. It is probably the plant referred to in the following passage from Theophrastus, dating from about 300 B.C.: "There is also another tree which is very large and has wonderfully sweet and large fruit; it is used for food by the sages of India who wear no clothes" (Enquiry into Plants IV, iv. 5, transl. Hort. 315. 1916). This was incorporated by Pliny (circa A.D. 77) into a longer account:

"Maiore alia pomo et suavititate praecellentiore, quo sapientes Indorum vivunt. folium alas avium imitatur longitudine trium cubitorum, latitudine duum. fructum cortice emittit admirabilem suci dulcedine, ut uno quaternos satiet. arbori nomen palae, pomo arienae. plurima est in Sydracis, expeditionem Alexandri termino" (Nat. Hist. XII. xii, Loeb ed. 4: 16. 1945). Yule and Burnell (Hobson-Jobson, Glossary of Anglo-Indian Words and Phrases, 335. 1886, ed. 2. revised Crooke, 440. 1903), who identified these passages as referring to the Jack, pointed out that Pliny's second sentence was derived (though apparently indirectly) from the next paragraph in Theophrastus, which could refer to the banana: "There is another tree whose leaf is oblong in shape like the feathers of the ostrich; this they fasten on to their helmets, and it is about two cubits long." (Hort, l.c.). This sentence caused the entire description to be applied to the banana by Bauhin (Pinax, 507. 1623) and by many later authors. The derivation of Pliny's names is uncertain, but Yule and Burnell suggested that *pala* might be the Sanskrit *phala* (fruit), while *ariena* was possibly *hiranya* (golden). The Sanskrit name for the Jack is *panasa*. The name *chakki* for the fruit is widespread in India, and it is from this that the European name is taken. Its source is doubtful, although it has been suggested that it may have come from the Malayalim word *chakka* (round).

In Malaysia, although the Jack is widely cultivated, it rarely occurs spontaneously, and then only in secondary vegetation. It thus gives the appearance of being an introduced plant and has always been regarded as such, although the introduction must have taken place at a very early date. It is generally known by an indigenous name, *nangka*, the origin of which is unknown. Ochse and Bakhuisen van den Brink (Fr. & Fr. Cult. Dutch E. Ind. 69. 1931) and Heyne (Nutt. Pl. Indonesië, ed. 3. 1: 560. 1950) record the Sanskrit name and variants from Sumatra and Celebes.

In southeastern Asia, the Jack is recorded only in cultivation. According to Lacouperie (Babylon. & Orient. Rec. 7: 169. 1894) it was mentioned from Indochina under the name *pa-na-so* in a Chinese account of Cambodia in the sixth century. He stated that it was first recorded from China in the herbal "Pen-ts'ao Kang Mu," which was compiled between 1552 and 1578, and he derived the Chinese names *po-lo-mih* and *po-lo-mat* from the Sanskrit *pala,* stating that they meant "honey *pala.*"

The Jack is now cultivated through most of the tropics, though it is generally of less importance than the Breadfruit, *Artocarpus communis*. In the New World it was brought to Brazil, according to Tavares (Broteria, Ser. Vulg. Sci. 13: 24. 1915), by the Portuguese in the middle of the seventeenth century. In 1782, plants taken from a French vessel destined for Martinique, but captured by Admiral Rodney, were introduced into Jamaica (Howard, Scientific American **188**: 88. 1953).

In India and Malaysia two main forms of the Jack are found, although there is apparently variation within each. In the more esteemed form the ripe fruit is firm, and the wall remains attached to the fruiting perianths and the core. The flesh of the fruiting perianths is firm and the seeds are enclosed by a horny endocarp. This is the form which was studied by Corner

and which has been described above. In India it is known as *varaka* or *barca*, meaning best, and in Malaysia it is called *nangka bilulang*. The second form, which is called *gerissal, vela* or *papa* in India and *nangka bubor* in Malaysia, is stated to have a soft, "baggy" fruit when ripe, as in the Chempedak. It appears to have other characteristics of *Artocarpus integer*, since Corner recorded that he had been informed by C. X. Furtado that, in fruits of this form from near Goa, the pulp surrounding the seeds was soft and the testa [pericarp] thin. Rumphius also described the soft pulp of *nangka bubor* and stated that the fruit had a stronger odour. These resemblances led Corner to suggest, no specimens being available, that it might be a glabrous variety of the Chempedak. However, all herbarium material seen from India has the decurrent leaf lamina and the annulus of the Jack. These characters are also shown by two collections, *Meijer 7117* (L, ♀) and *7142* (L, ♂), from Padang Pandjang, near Pajakumbuh, West Coast, Sumatra, which have the vernacular name *tjempedak bubur* and thus may represent this form. The female inflorescence is at anthesis and has the ligulate style found in *A. heterophyllus*. Nevertheless, the similarities between this form and the Chempedak are suggestive of some hybridization between the two species in the past. No genetical data are available beyond the record of a diploid number of 56, apparently the basic number for the genus, in *A. heterophyllus* (Subba Rao, Half Yearly Jour. Mysore Univ. Sect. B. Sci. **1**: 63. 1940). In Ceylon there is a third well-marked variety with small, round fruits called *kuru*.

Mendiola (Philip. Agric. **28**: 789. 1940) reported possible hybridization between the Jack and the Chempedak in the Philippines. He stated that plants raised from the seed of a few introduced Chempedak trees growing near *nangka* (Jack) trees produced fruits with mainly *nangka* characteristics, and that seedlings grown from these fruits were intermediate between those of the two species in several characters. This is the only report of such hybridization, but it is of interest in the light of the previous paragraph.

Series **Angusticarpi** Jarrett, ser. nov.

Folia simplicia, adulta integra, juvenilia praelonga vel trilobata, raro pinnatifida; hypodermis absens; glandulae semi-immersae, capitibus depresso-globosis, c. 6-cellis. *Inflorescentiae* ramulis latae. *Capitula mascula* superficie plana, floribus fertilibus vel aliquibus sterilibus, solidis praelongisque obtecta, bracteis absentibus. *Syncarpia* processibus appresse puberulentibus, aequalibus vel paucis solidis praelongisque obtecta, bracteis absentibus; semina testis pergamentaceis, rubris, pericarpiis pergamentaceis (? maturatis induratis), perianthiis tenuisque inclusa.

TYPE SPECIES: *Artocarpus teysmannii* Miq.

The characters of the pericarps are taken from *Artocarpus teysmannii*, and from the collections probably representing a new species which are briefly described under *Artocarpus lowii*. The differences between the

two species at present recognized in the series are also noted under *A. lowii.*

FIG. 14. Distribution of the species of series CAULIFLORI and ANGUSTICARPI and of the anomalous species. 14, *Artocarpus integer*; 15, *A. heterophyllus*, possible distribution as a wild plant; 16, *A. lowii*; 17, *A. teysmannii*; 25, *A. hirsutus*; 26, *A. nobilis*; 27, *A. sepicanus.*

16. **Artocarpus lowii** King in Hook. f. Fl. Brit. Ind. **5**: 542. 1888, et in Ann. Bot. Gard. Calcutta **2**: 10. *t. 7A*. 1889, pro maxima parte, flosculis bracteisque masculis exclusis; Ridley, Fl. Malay Penin. **3**: 353. 1924; Burkill, Dict. 257. 1935; Corner, Gard. Bull. Singapore **10**: 283. 1939, Wayside Trees, 656. 1940. Holotype, Perak, *King 7737* (CAL, not seen); isotypes (BM, K, SING).

Evergreen trees, height to 25 m., bark grey, smooth. *Twigs* 3–6 mm. thick, finely and shallowly rugose, appressed-puberulent; annulate stipular scars c. 0.5 mm. broad, prominent; lenticels few or absent. *Stipules* 2–12 cm. long, lanceolate, attenuate, appressed-puberulent. *Leaves* 11–36 × 4–13 cm., elliptic or narrowly elliptic, acute to short-acuminate, base cuneate, margin entire or shallowly crenate; juvenile leaves to 55 cm. long, narrowly elliptic, with an acumen to 2.5 cm. long, entire or trilobed; main veins prominent beneath, intercostals slightly so; glabrous above, appressed-puberulent on main veins beneath; lateral veins 11–16 pairs, straight; intercostals parallel; dark green, drying pale to dark red-brown above, lighter beneath; hypodermis absent; gland-hairs half immersed, heads depressed-globose, c. 6-celled; petiole 20–35 mm. long.

Inflorescences solitary in leaf-axils. *At anthesis*: *male head* 20–25 × 5 mm., cylindric, smooth, covered by flowers; perianths tubular, 0.8 mm. long, shortly bilobed above, minutely appressed-pubescent; stamen 1.5 mm. long, filament slender, cylindric, anther-cells ellipsoid, 0.2 mm. long; peduncle c. 40 × 1.5 mm., appressed-puberulent, also with subpatent,

recurved hairs hooked at the tips; *female head* with simple styles exserted to 0.5 mm. *Syncarp* to 6.5 × 3.5 cm., cylindric, yellow, drying brown, covered by closely set, fleshy, conical, appressed-puberulent processes c. 1.5 × 2 mm., or their apices becoming depressed and the surface hence areolate; wall c. 2 mm. thick; fruiting perianths numerous, proximal free region thin-walled, "seeds" (pericarps) ellipsoid, 10 × 8 mm., style subbasal, testa and embryo . . . ; core c. 5 mm. across; peduncle 35–55 × 2.5 mm., indumentum as male.

VERNACULAR NAME: *Miku*, Malaya. USES: the sap, which is apparently unique in this genus in being greasy, is used as an ointment.

DISTRIBUTION: In lowland evergreen forest, Malaya, Sumatra (East Coast).

Malaya. PERAK. Larut, Gunong Pondok, *King 7737*, June 1885 (BM, K, SING, ♀). PAHANG. Kuantan, *Munnick s.n.*, Aug. 1914 (SING); Putat reserve, *Alwi CF 10711* (SING); Raub, *Burkill & Haniff SFN 16649* (SING, ♀). SELANGOR. Kuala Lumpur, *Ridley 4708* (SING); Kuala Lumpur, Public Gardens, *Corner SFN 30775* (K, SING, ♀), *33542* (SING), *Foxworthy CF 4600* (K, ♀), *Hamid & Ja'amat CF 9982* (SING, ♀), *Omar CF 9512* (K, ♀), *Strugnell CF 12612* (SING); Kuala Lumpur, Weld Hills Res., *Hamid CF 986* (SING), *4966* (K, SING, ♀). NEGRI SEMBILAN. Tampin, *Nur 1315* (K, SING, ♀). MALACCA. *Maingay 1477* (K, ♀); Brisu, *Derry 30* (K, SING, ♀); near Durian Tunggal, *Corner SFN 30752* (SING); Sedanan, *Goodenough 1412* (P, SING); Selandar forest near Tebong, *Burkill SFN 534* (SING); Tebong, *Burkill SFN 1336* (SING). SINGAPORE. Bukit Timah, *Forbes s.n.*, Mar. 1893 (BM, ♀), *Kiah SFN 34964* (A, BO, K, L, P, SING), *Ridley 4719* (SING, ♀), *6810b* (SING); Chan Chu Kang, *Ridley 6810a* (SING), *Ridley s.n.*, June 1895 (BO, ♂); Garden Jungle, *Ridley s.n.*, 1907 (BO, ♀). **Sumatra.** EAST COAST. Huta Padang estate, near Kisarin, *Krukoff 322* (BM, BO). **Cultivated.** SINGAPORE. Hort. Bot., *Burkill s.n.*, June 1924 (SING), *Nur 1676* (SING), *Ridley 6810* (BO, SING, ♀).

King accidentally transposed the descriptions and drawings of the details of the male flowers in *Artocarpus lowii* and *A. teysmannii* (called by him *A. peduncularis* Kurz). The "ligulate scales" which he described for *A. lowii* are the sterile flowers of *A. teysmannii.*

In 1939, Corner pointed out that *Artocarpus lowii* and *A. teysmannii* (as *A. peduncularis*) differed in the elliptic versus ovate outline of the leaves and in the larger number of lateral veins present in the former. In addition, *A. teysmannii* has solid sterile flowers in both male and female inflorescences, stamens with larger anthers and broader filaments, and longer pubescence on the stipules. The appearance of the hooked hairs found on the peduncles in *A. lowii* is distinctive. The single collection of *A. lowii* cited from Sumatra is sterile and has no stipules, but it matches those from Malaya closely, having elliptic leaves with 12–17 pairs of lateral veins.

The following four collections probably represent a new species closely allied to, but distinct from, *Artocarpus lowii*. However, they are not being described as such until more adequate material, including the male inflorescence, is available. Three of the collections, all bearing submature syncarps, are from British North Borneo: *Clemens 27131*, Tenompok trail,

Mt. Kinabalu, 5000 ft. (A, BO, L, SING, ♀); *Carr SFN 27141*, Tenompok-Dallas path, Mt. Kinabalu, 4200 ft. (SING, ♀); *Wood SAN 16994*, Kandasan-Tenompok path, 12 miles w. of Ranau, 4750 ft. (L, ♀). The fourth collection, which is from Indochina, bears immature inflorescences with malformed flowers: *Poilane 35982*, near Dak Bro, Ngok San, Kontum prov., Annam, 1500 m. (P). The discontinuity in distribution is apparently similar to that shown by *Artocarpus melinoxylus*. The specimens match each other closely in their vegetative characters and in the appearance of the syncarps. The leaves are rather small, 9–18 × 3–5.5 cm., and elliptic to oblong-elliptic in outline. They are narrower than in *A. lowii* and have more widely spreading lateral veins (12–17 pairs). The leaf anatomy agrees well with *A. lowii*, since the glands are immersed, with depressed-globose, 6–8-celled heads, and there is no hypodermis. As in this species the shoots are glabrous except for the appressed-puberulent stipules and young twigs, but the peduncles lack the characteristic hooked hairs. The submature syncarps are similar to those of *A. lowii*, being cylindric, to 5 × 3 cm., and covered by low, conical processes, c. 1 × 2 mm., with a peduncle measuring up to 25 × 3 mm. (and also, in *Clemens 27131*, simple styles exserted to 1 mm.). Partly matured ovaries in *Wood SAN 16994* are subglobose, with the style one-third the distance up the ventral face, the wall becoming indurated, and a reddish, pergamentaceous testa.

17. **Artocarpus teysmannii** Miq. Fl. Ind. Bat. Suppl. 418. 1861, "*Teysmanni*"; Boerl. Handl. Fl. Ned. Ind. **3**: 333, 371. 1900; Heyne, Nutt. Pl. Indonesië ed. 3. **1**: 565. 1950. Holotype, Sumatra, *Teysmann HB 4387* (U); isotypes (BO, L).

Artocarpus peduncularis Kurz, Jour. Bot. **13**: 331. 1875; King in Hook. f. Fl. Brit. Ind. **5**: 541. 1888, et in Ann. Bot. Gard. Calcutta **2**: 10, *t. 6*. 1889, pro maxima parte, flosculis bracteisque masculis exclusis; Becc. For. Borneo, 632. 1902; Ridley, Fl. Malay Penin. **3**: 353. 1924; Burkill, Dict. 258. 1935; Corner, Gard. Bull. Singapore **10**: 283. 1939. Holotype, Nicobar Islands, *Kurz s.n.* (CAL); ? isotype (K, numbered *Kurz 26906*).

Evergreen trees, height to 45 m. *Twigs* 2.5–5 mm. thick, rugose, appressed-puberulent; annulate stipular scars c. 0.5 mm. broad, prominent; lenticels absent. *Stipules* 2–9 cm. long, lanceolate, acute or attenuate, appressed-pubescent, hairs yellow. *Leaves* 5–25 × 3–13 cm., ovate to ovate-elliptic, obtuse to acute or short-acuminate, base rounded to broadly cuneate, margin entire or shallowly crenate; juvenile leaves to 60 × 25 cm., elliptic, base cuneate, rarely pinnatifid; main veins prominent beneath; glabrous or nearly so above, appressed-puberulent on main veins beneath; lateral veins 6–12 pairs (–18 in juvenile leaves), straight; intercostals parallel; dark green, drying pale brown when mature, dark brown when immature; hypodermis absent; gland-hairs half immersed, heads depressed-globose, c. 6-celled; petiole 10–35 mm. long.

Inflorescences solitary in leaf-axils. *At anthesis*: *male head* 35–75 × 5–7(–9) mm., narrowly cylindric, smooth, covered by flowers, many sterile,

the perianths solid, filiform, projecting to 1 mm. from the surface (total length to 2.4 mm.); fertile flowers with perianths tubular, 1.4 mm. long, bilobed above, minutely pubescent; stamen 1.9 mm. long, filament broad, abruptly contracted above, anther-cells oblong, 0.5 mm. long; peduncle 20–80 × 3 mm., appressed-puberulent; *female head* with simple styles exserted to 1.5 mm. *Syncarp* to 8.5 × 2.2 cm., cylindric, yellow, nigrescent on drying, covered by closely set, fleshy, conical, appressed-puberulent processes, mostly perforate, c. 1.5 × 1.5 mm., a few solid, attenuate, to 4 mm. long; wall c. 1 mm. thick; fruiting perianths numerous, proximal free region thin-walled, "seeds" (pergamentaceous pericarps, ? submature) ellipsoid, 7 × 6 mm., style sub-basal, testa pergamentaceous, embryo (shrunken) with the radicle ventral and the cotyledons transverse to the median plane of the ovary, the upper cotyledon one-third the length of the lower; core c. 7 mm. across; peduncle 30–100 × 4 mm., appressed-puberulent.

VERNACULAR NAMES: *Chempedak ayer* (Malay), Malaya, Sumatra, Borneo; *Sali saling*, *Tipulu*, Celebes. USES: Heyne (1950) states that the timber is used for boats, and the latex as bird-lime.

DISTRIBUTION: In evergreen forest to 1000 ft., often on swampy ground, Nicobar Islands, Malaya, Sumatra, Borneo, Celebes, Moluccas (Sula Islands), western New Guinea.

Nicobar Islands. Kamorta, *Kurz s.n.*, Feb. 1875 (CAL, ♂, ♀), [? =] *Kurz 26906* (K, ♂, ♀). **Malaya.** PERAK. Ulu Bubong, *King 9530* (BM, CAL, K, L, ♀). SELANGOR. Sungai Tinggi, Kuala Selangor, *Nur SFN 34150* (A, SING, ♂), *Symington CF 44051* (SING). **Sumatra.** ATJEH. Singkel, Djangkar-kaling, *bb 10253* (BO); Singkel, Kampung Pamuka, *bb 3162* (BO, L, ♀). EAST COAST. Karolanden, Lao Solu, *bb 9295* (BO, ♀); Labuan Batu, Kola Napong, *bb 7382* (BO, ♀); Labuan Batu, Simatakasi, *bb 9761* (BO); Langkat, Pantei Tjermin, *bb 9123* (BO, ♀). INDRAGIRI. P. Gelang, *bb 29160* (A, BO, L, SING). DJAMBI. Simpang, *bb 12868* (BO). PALEMBANG. Lematang Ilir, Gunong Megang, *NIFS T 887* (BO, L, ♀); Musi Ilir, Petaling, *bb 8087* (BO). LAMPONGS. Kebang, *Teysmann HB 4387* (BO, L, U, ♀).

Borneo. SARAWAK. *Beccari PB 3937* (K, ♂); Baram, *Lumbor S 1252* (SING). WEST BORNEO. Kapuas, *Teysmann HB 7895* (BO, L); Sukadana, Kualan, *bb 6295* (BO, L, ♀). SOUTH AND SOUTHEAST BORNEO. Bandjermasin, *Motley 880* (K, ♂, ♀); Beneden Dajak, *Meegan VIII* (BO); Beneden Dajak, Pahandut, *bb 5551* (BO, ♂, ♀); Pasir, S. Ongka, *bb 25639* (A, BO, L, SING); Sampit, Kandan, *bb 2653* (BO, ♂, ♀); Sampit, Tampudan, *bb 2157* (BO); Sungei Kahajan, *bb 2094* (BO, L). EAST AND NORTHEAST BORNEO. W. Kutei, near Lahum, *Endert 1879* (K, L).

Celebes. Gulf of Boni, *Heyne 2856* (BO, L, ♀). CENTRAL CELEBES. Luwu, *Heyne 2551* (BO, ♂); Malili, Angkona, *bb 32359* (BO, L); Malili, Labose, *bb 11423* (BO, ♂); Malili, Usu, *bb 32607* (BO, L, ♀), *NIFS Cel./III–69 no. 131* (BO, L, ♂), *69 no. 186* (BO, ♀), *NIFS Cel./III–85* (BO, ♀), *86* (BO, ♂, ♀), *87* (A, BO, L), *88* (A, BO, L, ♀); Palopo, Baramamase, *bb 22983* (BO); Palu, Tomado, near Lindumeer, *bb 28240* (A, BO, L, SING, ♂, ♀); Poso, Kalora, *bb 28738* (A, BO, L); Tapalang, *Noerkas 443, 456* (BO, L). SOUTHWEST PENINSULA. Kp. Palima, *Noerkas 270* (BO, L). SOUTHEAST PENINSULA. Kolaka, Anaiwoi, *bb*

32545 (BO, L). P. MUNA. Raha, Wasalangka, *bb 21110* (BO, L), *21121* (BO). P. BUTON. Near Wakallea, *bb 4988* (BO, L, U, ♀). **Moluccas.** SULA ISLANDS. Mangoli, Tjapalulu, *bb 29908* (BO, L).

New Guinea. VOGELKOP. Manokwari, Momi, *Kostermans 347* (BO, L, SING); Ransiki, *Koster BW 1204* (L); Sorong, near Remu, *Pleyte 729* (A, K, L, SING, ♀); Wermenu, *bb 22524* (BO, L, ♀). DUTCH SOUTH NEW GUINEA. Sungei Aëndua, near Uta, *Aet 490* (K, L), [? =] *bb 32910* (L). SALAWATI. Kaloal, *Koster BW 1340, 1470* (L). **Cultivated.** JAVA. Bogor, Hort. Bot. *VIII B 52* (BO, L, ♂, ♀).

The appearance of the syncarp at maturity in *Artocarpus teysmannii* is somewhat variable, depending on the conspicuousness of the elongate solid perianths. In some collections these are not distinguishable, and this is so in the Kurz collection from the Nicobars which is the type of his *Artocarpus peduncularis*. However, the specimen has the ovate leaves characteristic of *A. teysmannii* and the syncarp peduncle measures 9–10 cm.; the male inflorescence is also typical of the species.

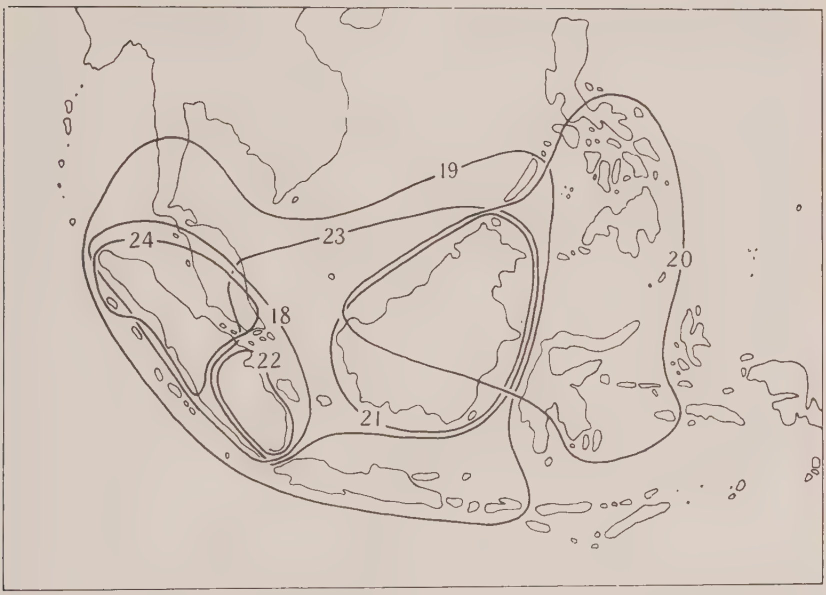

FIG. 15. Distribution of the species of series RUGOSI. 18, *A. scortechinii*; 19, *A. elasticus*; 20, *A. sericicarpus*; 21, *A. tamaran*; 22, *A. sumatranus*; 23, *A. kemando*; 24, *A. maingayi.*

Series Rugosi Jarrett, ser. nov.

Folia simplicia, adulta integra, juvenilia pinnatifida; hypodermis perfecta, strato unico ad triplico cellis isodiametricis composita; glandulae superficiales vel subimmersae, capitibus depresso-globosis, 4-cellis. *Inflorescentiae* ramulis latae. *Capitula mascula* superficie rugosa (sulcata ad tuberculata), floribus fertilibus obtecta, bracteis absentibus. *Syncarpia*

processibus pubescentibus vel hispidis, aequalibus (in *A. kemando* obsolescentibus) vel nonnullis solidis praelongisque obtecta, bracteis sparsis vel absentibus; semina testis carnosis, rubri-purpureis, pericarpiis corneis perianthiisque tenuis vel subcarnosis inclusa.

TYPE SPECIES: *Artocarpus elasticus* Blume.

It has been possible to examine the internal structure of the mature syncarp in only three out of the seven species recognized in the series (*Artocarpus elasticus*, *A. sericicarpus* and *A. kemando*), but in these the appearance of the thin, horny pericarp and the rather thick, fleshy, reddish-purple testa is distinctive. The embryo is consistently somewhat curved, but the orientation is variable. In *Artocarpus sericicarpus* the long axis is vertical, with the radicle about halfway down the ventral face. In *Artocarpus elasticus* and *A. kemando*, on the other hand, the long axis is horizontal and the embryo is subreniform, with the lower face concave over the sub-basal hilum and the radicle also sub-basal.

As is indicated above in the key to the species, the members of this series may be divided into two groups on the basis of the size of their parts. The first four species have more or less massive shoots and, in all except one, the processes on the syncarp are markedly dimorphic. They are readily separable from each other on the size and indumentum of these processes, on the surface of the male head, and on the texture, indumentum and number of lateral veins of the leaves. The remaining three species are rather slenderly constructed, and the syncarp has short or obsolescent processes, all similar to each other. These species are more closely related to each other, but they can be distinguished by the surface of the syncarp, and usually also by minor characters of the peduncles and leaves, which are commented on in the notes on *Artocarpus sumatranus* and *A. kemando*.

18. **Artocarpus scortechinii** King in Hook. f. Fl. Brit. Ind. 5: 542. 1888, et in Ann. Bot. Gard. Calcutta 2: 12. *t. 9*. 1889; Ridley, Fl. Malay Penin. 3: 355. 1924; Corner, Wayside Trees, 657. 1940. Syntypes, Perak, *King 7792* (CAL, not seen; duplicates examined, BM, K, SING), *Scortechini s.n.* (CAL, not seen).

Evergreen trees, height to 35 m. *Twigs* 8–15 mm. thick, rugose, minutely appressed-hispid; annulate stipular scars c. 1 mm. broad, slightly prominent; lenticels in an irregular ring below scar. *Stipules* 5-17 cm. long, broadly lanceolate, acute, subappressed-pubescent, hairs yellow to rufous. *Leaves* 15–40 × 8–20 cm., elliptic to ovate-elliptic, short-acuminate, base rounded to broadly cuneate, margin entire or shallowly crenate; juvenile leaves pinnatifid; main veins and intercostals prominent beneath, lower surface usually bullate between the meshes of the reticulum; glabrous or nearly so above, subappressed pubescent or hispid-pubescent beneath; lateral veins 12–14 pairs, straight; intercostals parallel, bright green, drying pale or reddish brown; hypodermis of 1 or 2 cell-layers present, complete, cells isodiametric in surface view; gland-hairs slightly immersed, heads depressed-globose, 4-celled; petiole 25–50 mm. long.

Inflorescences solitary in leaf-axils. *At anthesis*: *male head* 65–105 × 10 mm., cylindric, the surface sulcate, with long, shallow, sometimes few grooves, covered by flowers; perianths tubular, 0.6 mm. long, bilobed above, minutely pubescent; stamen 0.9 mm. long, filament cylindric, anther-cells oblong, 0.25 mm. long; peduncle 35–50 × 3 mm., shortly appressed-pubescent; *female head* with bifid styles exserted to 0.5 mm. *Syncarp* to 8.5 × 5.5 cm. (to 13 cm. long, fide King, 1889), cylindric, yellow, drying brown, covered by closely set, fleshy, cylindric, obtuse or truncate, shortly hispid-pubescent processes, mostly c. 3 × 2 mm., a few sometimes to 4 mm. long; wall c. 3 mm. thick; "seeds" (pericarps) numerous, ellipsoid, 8 × 7 mm.; core c. 12 mm. across; peduncle 55–95 × 5 mm., short-pubescent.

Vernacular name: *Terap* (Malay), Malaya, Sumatra.

Distribution: In evergreen forest to 2500 ft., Malaya, Sumatra, Lingga Archipelago.

Malaya. Perak. Batang Padang District, Turu, *King 7792*, July 1883 (bm, k, sing, ♀). Pahang. Kuala Lipis, *Burkill & Haniff SFN 15680* (k, sing). Selangor. Kuala Lumpur, Public Gardens, *Ahmad CF 4990* (k, ♀). Negri Sembilan. Bukit Sutu, *Alvins 1896* (sing, ♀). Malacca. *Griffith 4660* (k, ♂, ♀). Penang. Government Hill, *Burkill 2892* (k, sing, ♂, ♀), *Curtis s.n.* (sing). Singapore. Kranji, *Goodenough 3379* (cal, sing, ♀); Tangka, *Ridley 11366* (k, sing, ♀); behind Tyersall, *Hullett s.n.*, 1893 (sing, ♀).

Sumatra. Atjeh. Wassenar, *Batten-Pooll s.n.*, July 1939 (sing). Tapanuli. Lapian, Sibolga, *bb 3801* (bo). East Coast. Boven Lankat, *bb 9149* (bo, ♂); Ulu Tesso, *bb 27661* (bo, l); Sigati River, *Koorders 10452* (bo). Indragiri. Belimbing, *bb 28499* (bo, l); Danau Mengkuang, *bb 27520* (bo); Muara Serangge, *bb 30009* (bo, l, sing), *30072* (a, bo, l). Palembang. *Castillo & Valderrama 4* (a, k); Banjuasin and Kubustreken, *Grashoff 824* (bo, l); Banjuasin, Bajunglintjir, *NIFS E 787* (bo, l, ♂, ♀); Lematang Ilir, Gunong Megang, *NIFS T 811* (bo, l, ♀); Lematang Ilir, Semangus Reserve, *bb 31677* (bo, l). Lampongs. *Teysmann s.n.* (bo). Lingga Archip. Manggu, *bb 5616* (bo, l, ♂, ♀). **Cultivated.** Malaya. Singapore, Hort. Bot., *Corner s.n.*, Feb. 1937 (sing, ♀), *Nur 265* (sing, ♀), *Ridley 5690* (bm, sing, ♀), *6431* (cal, k, sing, ♂), *6543* (cal, sing, ♂).

Artocarpus scortechinii is smaller in all its parts than *A. elasticus*, and may usually be distinguished from the latter, when sterile, by the upper surface of the leaf, which is smooth or nearly so. A few of the processes on the syncarp may be slightly elongate, but all are perforate and have styles exserted at anthesis.

One collection seen from the Kanching Forest Reserve, Selangor, Malaya, *Nur SFN 34427* (a, sing, ♀), has characters which are somewhat intermediate between *Artocarpus scortechinii* and *A. elasticus*. It has the general appearance of *A. scortechinii* but the dimensions are rather large: the leaves measure up to 36 × 20 cm. and are slightly scabrid above, the twigs are about 15 mm. thick, and the syncarp measures 11 × 4.5 cm., with a peduncle 7 cm. long, and has many somewhat elongate, solid processes about 5 mm. long. The collection appears to be from a hybrid between

the two species and, if so, this is the only naturally occurring hybrid in *Artocarpus* which has been recognized in the material examined in the course of this study. Seeds are present in the syncarp and are apparently fully developed.

19. **Artocarpus elasticus** Reinw. ex Blume, Cat. Bog. 101. 1823, nomen nudum, Bijdr. 481. 1825, "*elastica*"; Miq. Fl. Ind. Bat. 1(2): 285. 1859, Ann. Mus. Lugd.-Bat. 3: 211. 1867, pro parte excl. spec. *De Vriese*, Batjan; Koord. & Val. Bijdr. Boomsoort. Java 11: 13. 1906; Van Steenis, Bull. Jard. Bot. Buitenzorg III. 13: 12. 1933; Burkill, Dict. 251. 1935; Corner, Wayside Trees, 653. *t. 193, 194.* 1940; Backer, Beknopte Fl. Java 6: 13. 1948. Holotype, Java, *Reinwardt s.n.* (L).

Artocarpus blumii Tréc. Ann. Sci. Nat. Bot. III. 8: 111, *t. 4, fig. 116.* 1847; Miq. in Zoll. Syst. Verz. Ind. Archip. 2: 89. 1854; Miq. Fl. Ind. Bat. 1(2): 285. 1859, Ann. Mus. Lugd.-Bat. 3: 211. 1867; Kurz, Natuurk. Tijdschr. Ned. Ind. 27: 182. 1864; Becc. For. Borneo, 632. 1902; Renner, Bot. Jahrb. 39: 366. 1907. Syntypes, Java, *Blume s.n., Zollinger 1058* (P); lectotype, *Zollinger 1058* (P).

Artocarpus kunstleri King in Hook. f. Fl. Brit. Ind. 5: 540. 1888, et in Ann. Bot. Gard. Calcutta 2: 9. *t. 4.* 1889; Ridley, Trans. Linn. Soc. Bot. II. 3: 355. 1893, Fl. Malay Penin. 3: 353. 1924. Syntypes, Malaya, *King 3494, 6799, 6967, 10965, Maingay 1484* (CAL, not seen; duplicates examined, K, SING, etc.).

Artocarpus blumei Tréc. var. *kunstleri* Boerl. Handl. Fl. Ned. Ind. 3: 370. 1900.

Artocarpus pubescens auct. non Willd., Blume, Bijdr. 481. 1825; Moritzi, Syst. Verz. 75. 1846.

Evergreen (? or deciduous) trees, height to 45 m. (–65 m., fide *bb 8769*), strongly buttressed when old (fide Corner, 1940), bark dark grey, *Twigs* 10–20 mm. thick, rugose, short-hispid, hairs patent or appressed; annulate stipular scars c. 1 mm. broad, slightly prominent; lenticels in an irregular ring below scar. *Stipules* 6–20 cm. long, broadly lanceolate, attenuate, hispid-pubescent, hairs yellow to rufous, patent or appressed. *Leaves* 15–60 × 10–35 cm., ovate-elliptic, short-acuminate, base rounded or cuneate, margin entire or shallowly crenate; juvenile leaves twice or thrice pinnatifid, to 200 cm. long; main veins and intercostals prominent beneath, reticulum slightly so, lower surface bullate between the meshes of the reticulum; very shortly appressed-hispid above with the main veins pubescent, subappressed hispid-pubescent beneath; lateral veins 12–14 pairs, straight; intercostals parallel; dark green above, pale green beneath, drying purplish to reddish brown above, red-brown beneath; hypodermis of 1–3 cell-layers present, complete, cells isodiametric in surface view; gland-hairs slightly immersed, heads depressed-globose, 4-celled; petiole 40–100 mm. long.

Inflorescences solitary in leaf-axils. *At anthesis*: *male head* 60–150(–200) × 15–25 mm., cylindric, the surface sulcate with long, deep grooves, covered by flowers; perianths tubular, 0.8 mm. long, bilobed above, appressed-

pubescent; stamen 0.9 mm. long, filament broad, flattened, anther-cells oblong, 0.4 mm. long; peduncle 40–75 × 3 mm., short-pubescent; *female head* with bifid styles exserted to 1 mm. *Syncarp* to 11.5 × 5.5 cm. (to c. 17 × 10 cm. including processes), cylindric, yellow-brown, drying brown, covered by closely set, fleshy, short-hispid processes of two lengths, the longer flexuous, slightly tapering, solid, 10–18 × 1–1.5 mm., the shorter narrowly conical, perforate, 4 × 1 mm.; scattered bracts present between the processes, very slenderly stalked, heads infundibuliform, c. 0.2 mm. across; wall c. 6 mm. thick; fruiting perianths numerous, proximal free region white, somewhat fleshy, "seeds" (thin, horny pericarps) ellipsoid, 10 × 6 mm., style one-third the distance up the ventral face, testa fleshy, embryo with the radicle ventral, the cotyledons parallel to the median plane of the ovary, equal; core 20–30 mm. across; peduncle 65–120 × 10 mm., short-pubescent.

VERNACULAR NAMES: *Aw* or *Ka aw*, Tenasserim and peninsular Siam; *Terap* (Malay), Malaya, Sumatra and Borneo; *Teureup*, (Sundanese), *Bendo* (Javanese), Java. USES: the seeds are eaten roasted but, although the flesh tastes sweet (fide Koorders & Valeton, 1906), the ripe fruit has a nauseous smell (fide Corner, 1940); cloth is made by aboriginal tribes from the bark; the latex is used for bird-lime.

DISTRIBUTION: In evergreen forest to 1000(–4500) ft., tolerant of a short dry season, peninsular Burma and Siam, Malaya, Sumatra and islands off the west coast and in the Sunda Straits, Riouw Archipelago, Billiton, Borneo, Java, Lesser Sunda Islands (e. to Sumbawa), Palawan.

Burma. TENASSERIM. South Tenasserim, Nwagun Valley, *Parkinson 1636* (K). **Siam.** PENINSULAR SIAM. Banang Sta, Pattani, *Kerr 7389* (BM); Bang Son, *Kerr 1563* (BM); Kao Luang, near Sritamarat, *Kerr 15563* (BM); Narathiwas, Ruesaw, *Thathiamrom 2364* (CGE, ♀).

Malaya. KEDAH. 58th mile Wong Baling, *Chew Wee Lek 130* (K, ♂). PERAK. *King 10965* (K, SING, ♂, ♀); Grik, *Burkill & Haniff SFN 12533* (SING, ♀); 11th mile toward Jor, from Tapah, *Haniff SFN 14293* (SING); Larut, *King 3494*, Oct. 1882 (BM, K, L, ♂, ♀), *6799*, Nov. 1884 (BM, K, P); Larut, Turu, *King 6967*, Dec. 1884 (SING, ♂); Simpang, *Wray 2035* (SING, ♂, ♀); Taiping, *Wray s.n.* (SING); 10th mile Tapah-Pahang road, *Burkill & Haniff SFN 13441* (SING, ♀). PAHANG. Kuala Lipis, *Burkill & Haniff SFN 15680* (K, SING, ♀); Kuala Temkelis, *Ridley 2328* (SING, ♂, ♀); Tembeling, *Henderson SFN 21899* (A, BO, SING, ♀), *Ridley s.n.*, 1891 (SING, ♀). SELANGOR. Batu Tija, *Ridley s.n.*, Feb. 1904 (SING). MALACCA. *Maingay 1484* (GH, K, L, ♂, ♀). JOHORE. Patani Keohil, Batu Pahat, *Ridley s.n.*, Nov. 1900 (SING, ♀). PENANG. Waterfall, *Curtis s.n.*, July 1893 (SING, ♂, ♀). SINGAPORE. Bukit Panjang Res., *Ridley s.n.*, Feb. 1899 (SING). (Fide Corner, 1940, common in lowland forest throughout Malaya.)

Sumatra. ATJEH. Sokoluway, *Batten Pooll s.n.*, 1939 (SING). TAPANULI. Barus, *bb 31581* (BO, L); Padang Lawas, Purbasinamba, *bb 6196* (BO). WEST COAST. Melintang, *sine nom. et num.* (L); Ophir, Lubuk Gadang, *bb 18739* (BO); Ophir, Lubuk Gadang, Parek, *bb 19484* (BO), *19627* (BO, L); Ophir, Simpang, *bb 18722* (BO); Pajakumbuh, *sine nom. et num.* (BO, ♂); Priaman, *HB 754* (L); Sidjungdjung, Muaro, *bb 5203* (BO, L), *9049* (BO, L, U, ♀). EAST

COAST. Asahan, Bandar Puluh, *Yates 1899* (BO, P, ♀); Huta Padang Estate, near Kisarin, *Krukoff 203* (BO, ♂), *301* (BO), *4367* (A, BO, L, SING, ♀); P. Mendol, *bb 21459* (BO, L); Sibolangit, *Lörzing 5861* (BO, L, U, ♂, ♀). INDRAGIRI. Belimbing, *bb 28502* (BO, L); Kuala Keritang, *bb 28697* (BO, L); Kwantan, Muara Pantei, *bb 23862* (BO, L); Padang Tarab, *Koorders 10457* (BO); Pulau Pauh, *Koorders 10459* (BO). DJAMBI. Simpang, *bb 13121* (BO). BENKULEN. Kruï, G. Kemala, *bb 8769* (BO); Redjang, Tabah Penandjung, *bb 1807* (BO, L). PALEMBANG. Djankar, Pasemahlanden, *bb 8683* (BO, L); Komering Ulu, *Grashoff 603* (BO); Lematang Ilir, Semangus, *bb 32172* (BO, L); Lematang Ulu, *Lambach 1215* (BO, L, ♀); Martapura, *Bal 43* (BO); Muara Dua, *Teysmann HB 3778* (BO); Muara Dua, Kisau, *bb 9230* (BO); n.w. of Ranaumeer, Gunong Pakiwang, *Van Steenis 3887* (BO, L, SING, ♂). LAMPONGS. Menggala, *bb 8470* (BO, L, U); Seputih, Suwikis, *bb 2856* (BO); Seputih-Tulangbawang, Gunung Sugit, *Gusdorf 139* (BO, ♀); Telukbetong, Ibadjimenah, *bb 8094* (BO, L, U). SIMALUR. *Achmad 89* (BO, L, ♀), *545* (BO, L). NIAS ISLAND. *Hagerup s.n.* (C), *sine nom. et num.* (L). BATU ISLANDS. Pulau Tello, *Demang s.n.* (BO). ENGGANO. Near Bua Bua, *Lütjeharms 4417*, *4754* (A, BO, K, L, P, SING). ISLANDS IN THE SUNDA STRAITS. Krakatau group: Lang Eiland, *Docters van Leeuwen-Reijnvaan 14231* (BO); Verlaten Eiland, *Backer s.n.*, May 1908 (L), *Boedijn 2326* (BO). Pulau Sebisi, *Docters van Leeuwen-Reijnvaan 5388* (BO, ♀). BILLITON. *Teysmann s.n.* (BO), *HB 17584* (BO); Tandjungpandan, *sine nom. ct num.* (BO); Tandjungpandan, Banlan, *bb 8676* (BO, L). RIOUW ARCHIP. Karimon: Simpangbanan, *bb 9967* (BO); Tandjong Pundur, *bb 6310* (BO, L).

Borneo. SARAWAK. *Beccari PB 1037* (K, ♀); Kuching, Sungei Semangoh For. Res., *Xuas S 0184* (SING, ♀). WEST BORNEO. B. Lampai, *Teysmann HB 7101* (BO, P); Pontianak, Olakolak, *bb 12634* (BO); Sanggau, Ketatai, *bb 18573* (BO). SOUTH AND SOUTHEAST BORNEO. Dusun [= Barito River] *Korthals s.n.* (L); Tanah Bumbu, Kampong Baru, *bb 13055* (BO, ♀). EAST AND NORTHEAST BORNEO. Berouw: Betemaran, *bb 19039* (A, BO, L); Betemuaer, *bb 19109* (BO, P); Domaring, *bb 18896* (BO, K). E. Kutei: Bengalon Rapak, *bb 15318* (BO, L), *15327* (BO); Rapak, *bb 14622* (BO, ♀); Samarinda, *sine nom. et num.*, 1926 (BO); Sangkulirang, Landak, *bb 14843* (BO, ♂); Sangkulirang, Rantau Bahan, *bb 15219*, *15220* (BO, L), *15223* (BO, K, L), *15227* (BO, L), *15241* (BO, K, L), *15254* (BO); T. Lelan, *bb 14689* (BO, L, ♂), *14692* (BO, ♂). W. Kutei: Kendisi, *bb 16690* (BO); Longbleh, *bb 16130* (A, BO, L), *16131* (BO, SING), *16132* (BO); Mujup, *bb 16770* (BO, K). P. LAUT. Sungei Paring, *bb 13197* (BO).

Java. *Blume s.n.* (P), *Junghuhn s.n.* (L), *Lahaie 2212* (P), *Reinwardt s.n.* (L), *Zippelius s.n.* (L). WEST JAVA. Bantam: Batuhideung, Tjimara, Gunong Merang, *Koorders 8699* (BO, L). Batavia: Bidara Tjina, *Edeling 7277* (BO, P, ♂); Depok, *Beumée 5679* (BO, ♀), *Büsgen 17* (BO, L), *Koorders 42229* (BO), *Van Steenis 5663* (BO, ♂), *Backer 35151* (BO); Djasinga, *Smith 10484* (BO, ♀); Dungus, 10 km. from Djasinga, *NIFS Ja 1973* (BO); Kebajosa, *Backer s.n.* (BO, ♀); Meester Cornelis, *Backer 35316* (BO). Buitenzorg: Kotaparis, *Bakhuizen van den Brink 1817* (U); Tjilinung, *Hallier s.n.* (BO). Preanger: Palabuanratu, Sukabumi, *Koorders 8696*, *8698* (BO, L), *11843* (BO, K, L, P, ♂, ♀), *11844* (BO, L, ♂), *11845* (BO, L, P, ♂, ♀), *11846* (A, BO, L), *33101* (BO); Garut, Pangentongan-Telagabodas, *Koorders 14123* (BO, L), *26173* (BO, L, ♂, ♀); Tjiandjur, Sukanagure, *Koorders 8697* (BO); Tjikoja, *Zollinger 1058* (BM, P, U, ♀). CENTRAL JAVA. Banjumas: Pringombo, Bandjarnagara, *Koorders 39144* (BO, K, L, P, ♂, ♀); Pringombo, Bongkelan, *Koorders 39176* (BO, ♂); Pringombo, Singomerto, *Koorders 8711* (BO, ♀), *8712* (BO, L, ♀). Djapara: *Koorders*

19 (BO); Kudus, Sumanding, *NIFS Ja 1811* (BO). Pekalongan: Margasari, *Berger 7371* (BO, ♂, ♀). *Noltée 4053* (BO, L, ♀); Subah, *Koorders 11638* (BO, ♀), *11639* (BO, L), *13358*, *13359*, *13362*, *36891*, *36959* (BO). Semarang: Gunong Andong, *Koorders 36617* (BO); Karangasem, *Koorders 8708* (BO), *8709* (BO, L), *28441* (BO); Kedungdjati, *Koorders 8700* (BO), *8701*, *8703* (BO, L), *8704*, *8705* (BO), *8707* (BO, L), *25027* (BO), *26097* (BO, L); Telomojo, *Koorders 28013* (BO, L), *36237*, *39278* (BO). Rembang: Sekar, Tambakredjo, *NIFS Ja 1592* (BO). Tegal: Kalisalak, *Koorders 8710* (BO). EAST JAVA. Besuki: Banjuwangi, Rogodjampi-Balak, *Koorders 8727* (BO); Djember, Glundengan, *NIFS Ja 2707* (A, BO, L, SING); Djember, Puger, *Koorders 8719* (BO, L); Djember, Tjuramanis, *Koorders 8720*, *8721* (BO, L), *8722* (BO, ♂), *8723* (BO, L), *8725* (BO), *8726* (BO, L), *38465*, *38557*, *39932*, *39966* (BO); Muntjar, *Becking 82* (BO); Situbondo, Pantjur-Idjen, *Koorders 8715* (BO, L), *8716* (BO), *8717* (BO, L, P), *8718* (BO, L). Kediri: Gadungan, Pare, *Koorders 23027* (BO); Klino, *NIFS Ja 2000* (BO, L), *Kalshoven 31* (BO). Madiun: Gunong Pandan, *Koorders 12381* (BO); Lawu, near Plaosan, *Elbert 302* (L); Ngebel, *Koorders 8706* (BO, L); Ngebel, Gondowido, *Koorders 29843* (BO); Ngebel, Gunong Wilis, *Koorders 38804* (BO). Malang: Gunong Baung near Lawang, *Bijhouwer 81* (BO, L); Karangputih, *Kalshoven XII* (BO). Probolinggo: Lumadjang, Gunong Sawur-waderan, *Koorders 8724* (BO, L). NUSA KAMBANGAN. *Koorders 8713*, *8714*, *20081*, *20089*, *20150* (BO, L), *22031* (BO, L, P), *24658*, *27034* (BO, L). KANGEAN ARCHIP. G. Eteng near Tambajangan, *Backer 27848* (BO). MADURA. Sampong, *Vordermans 125*, *129* (BO). P. BAWEAN. *NIFS Ja 4220* (BO, L, ♂, ♀).

Lesser Sunda Islands. BALI. Karang Asem, Besakilj, *bb 13278* (BO); Tjandikusuma, *Becking 128*, *135* (BO). LOMBOK. W. Lombok, Batukumlung, *bb 15501* (K, L). SUMBAWA. *Colfs 348* (L). **Philippine Islands.** PALAWAN. Aborlan, Iraan Mts., *Sulit PNH 12489* (A, L, ♂).

In publishing the name *Artocarpus elasticus*, Blume ascribed it to Reinwardt and gave a brief description of the male inflorescence and of pinnatifid leaves. The type is taken to be a sterile specimen in the Rijksherbarium, Leiden, bearing a single pinnatifid juvenile leaf and labelled by Reinwardt "Artocarpus elastica Rwdt." There are no specimens in the herbarium bearing this name that were determined by Blume himself. At the same time (1825) Blume described collections with entire leaves and both male and female inflorescences under the name *Artocarpus pubescens* Willd., which is a superfluous name for *A. hirsutus* from southern India.

Artocarpus elasticus is the commonest species of the genus in western Malaysia, but it is probably often under-collected, both because it is well known and because of the large size of the leaves. Thus Corner (1940) remarks that it is common throughout the lowland forests of Malaya, but from several of the states no collections have been seen in the course of this study. It is noted by Corner that *A. elasticus* may be deciduous in those areas of Malaya in the north and east that have a distinct dry season. Except for Palawan, from which a single collection has been seen, *Artocarpus elasticus* is apparently absent from the Philippines and all records in the literature must be transferred to the following species, the newly described *A. sericicarpus*.

Under the name *Artocarpus blumeana* Tréc. [sic], Schumann and Hollrung (Fl. Kais. Wilhelmsland, 39. 1889) recorded a collection, *Hollrung*

47, from Finschhafen, northeastern New Guinea, stating that the fruit was the size of an apple, with a brown rind, yellow flesh and small seeds. This collection was presumably destroyed at Berlin and no duplicate has been seen. It cannot be identified from the description and it was not mentioned by Diels in his "Die Moraceen von Papuasien" (Bot. Jahrb. **67**: 171–235. 1935).

20. **Artocarpus sericicarpus** Jarrett, sp. nov. Holotype, Luzon, *Merrill 2024* (US); isotype (K).

Gumihan Kamel in Ray, Hist. Pl. **3**, App. 52. 1704.
Artocarpus blumii auct. non Tréc., Vidal, Revis. Pl. Vasc. Filip. 254. 1886; Elmer, Leafl. Philip. Bot. **2**: 613. 1909.
Artocarpus elasticus auct. non Blume, Fern.-Villar, Noviss. App. 202. 1880; Stapf, Kew Bull. **1894**: 108. 1894; Wester, Philip. Agr. Rev. **8**: 109. *t. 8a.* 1915, Bull. Bur. For. Philip. **39**: 78. *t. 19b, 32c.* 1924; Merr. Enum. Philip. Pl. **2**: 41. 1923; Brown, Useful Pl. Philip. **1**: 463. *fig. 188.* 1941.

Differt ab *A. elastico* et *A. tamaran* inflorescentiis masculis capitulis subtuberculatis ad rugosis, floribus pilis crispis obtectis, femineisque processibus solidis longioribus (20–35 mm.), pilis longis subappressisque, obtectis, etiam ab *A. elastico* foliis supra laevibus, ab *A. tamaran* nervis lateralibus utrinque 11–16, nec 15–23.

[Arbores ad 30(–40) m. altae.] *Ramuli juniores* [6–]15 mm. diametro, rugosi, praesertim infra nodos [pubescentes vel] villosi, pilis rufis, [appressis vel] patentibus; cicatrices stipularum annulatae, 1 mm. latae, parum prominentes, conspicuae; lenticellae infra nodos circum ramulos inaequaliter dispositae. *Stipulae* 8 [6–12] cm. longae, late lanceolatae, acutae, villosae, pilis rufis, [subappressis vel] patentibus, etiam appresse pubescentes, pilis canescens. *Folia* c. 40 × 25 [20–70 × 10–50] cm., elliptica vel ovata, breviter acuminata, basi rotunda vel cuneata, laciniis lateralibus binis brevibus [adulta integra, margine integerrima, vel leviter crenata, juvenilia plus minusve pinnatifida], supra laevia, interdum scabriuscula, pilis minutis appressis, subtus pubescentia, viridia, in sicco rufibrunnea; costa nervi lateralesque subtus prominentes; nervi laterales utrinque 12 [11–16], recti; nervi transversales paralleli, subtus prominuli; areolae inter retem venularum subtus bullatae; hypodermis strato unico [vel duplico] cellis superne isodiametricis composita; glandulae subimmersae, capitibus depresso-globosis, 4-cellis; [petiolus 20–75 mm. longus].

Inflorescentiae axillis foliorum solitariae. *Ad anthesin*: *capitulum masculum* (immaturum) 35 × 15 mm. [–100 × 20 mm., unicum maturum visum], superficie subtuberculata ad rugosa, floribus numerosissimis obtecta; [perianthia tubulosa, 1.5 mm. longa, supra bilobata, lobis pilis crispis obtecta; stamina 1.8 mm. longa, filamentis latis, supra arcte contractis, cellis antherum oblongis, 0.4 mm. longis;] pedunculus 30 [matura 55–100] × 4 mm., appresse pubescens; *capitulum femineum* 4.5 × 4 cm., subglobosum, stylis simplicibus ad 1 mm. exsertis. [*Syncarpia* ad 8.5 × 5 cm (processibus exclusis), ellipsoidea vel cylindrica, fulva, in sicco brunnea,

processibus crebris duarum longitudinum, carnosis obtecta; processus longiores flexuosi, teretes, solidi, 20–35 × 0.5–1 mm., pilis longis, subappressis obtecti, breviores anguste conici, perforati, 3–6 × 1 mm., appresse pubescentes; bracteae interflorales rarae, tenuissimae, capitibus infundibuliformibus, c. 0.2 mm. latis; stratum externum syncarpii c. 2 mm. crassum; "semina" (pericarpia cornea) numerosa, ellipsoidea, 10 × 6 mm., perianthiis liberis, albis, subcarnosisque inclusa; embryum radicula ventrali, cotyledonibus subaequalibus, oblique positis; axis syncarpii 15–20 mm. diametro; pedunculus 95–180 × 6 mm., appresse pubescens.]

VERNACULAR NAMES: *Terap* (Malay), Borneo; *Gomihan* or *Gumihan*, Philippines. USES: the seeds are eaten roasted and Wester (1924) states that the juicy perianths surrounding them are sweet and aromatic with a fair to good flavour.

DISTRIBUTION: In evergreen forest to 1000(–3000) ft., Borneo, Philippine Islands, Celebes, Moluccas.

Borneo. SARAWAK. Banting, *Hewitt s.n.*, Sept. 1908 (K); Kuching, *Dickson s.n.*, Oct. 1952 (SING, ♂), *Haviland 1774* (CAL, SING, ♂). EAST AND NORTHEAST BORNEO. Berouw: Domaring, *bb 18877* (BO); Inaran, *bb 12132* (BO); Sungei Pulai, *bb 19190* (BO), *19194* (BO, SING). Bulungan: Salembatu, Sungei Rumah, *bb 11289* (BO). E. Kutei: Rapak, *bb 14625* (BO, L, ♂). W. Kutei: Upper Mahakam, Bato Urah, *bb 20677* (A, BO). BRITISH NORTH BORNEO. *The Governor s.n.*, Dec. 1893 (K, leaf with drawing of fruit).

Philippines. LUZON. Tayabas: Linayangan, *Merrill 2024*, Jan.–Apr. 1903 (K, US, ♂, ♀); Lucban, *Elmer 9160* (A, BO, K, L, ♀); Mt. Binuang, *Ramos & Edano BS 28855* (US, ♀). Camarines: Nueva Caceres, *Vidal 920* (K); Tigao, *Wester s.n.*, June 1915 (A, ♀). Albay: *Curran FB 10597* (NY, US, ♀). Sorsogon: Gubat, *Vidal 3845* (K, ♀). SAMAR. *Ramos BS 17596* (BM, K, US, ♂, ♀); Wright, Loquilocon, Sitio Tinane, *Sulit PNH 6147* (A, ♂, ♀). BILIRAN. *McGregor BS 18532* (A, BO, ♀). NEGROS. Oriental, Dumaguete, Cuernos Mts., *Elmer 10307* (A, BM, BO, K, L, US, ♀). MINDANAO. Surigao: *Hutchinson 7562* (NY). Bukidnon: Mindagat, Manai, *Pelzer PNH 13561* (A, L, PNH, ♂, ♀).

Celebes. NORTH PENINSULA. Kwandang, Titidu, *bb 7496* (BO); Minahassa, Liwutung, *Koorders 19041* (BO); Minahassa, Kajuwatu, *Koorders 19039* (BO); Minahassa, Lobu, *sine nom. et num.*, Dec. 1906 (BO). CENTRAL CELEBES. Luwu, *Heyne 2883* (BO); Malili, Kawata, *NIFS Cel./V–241 no. 235* (BO, ♂, ♀), *241 no. 308* (BO, L, ♀); Malili, Tomoni, *bb 32458* (BO, L); Malili, Usu, *NIFS Cel./II–499* (A, BO, L, SING); Palopo, Baramamase, *bb 22985* (L); Poso, Kalora, *bb 28729* (BO, L); Tapalang, *Noerkas 444* (BO). SOUTHEAST PENINSULA: B. Watuwila, *Kjellberg 984* (S, ♀).[11] P. MUNA. Raha, Wasalangka, *bb 21310* (BO, K).

Moluccas. TALAUD ISLANDS. Karakelang, Gunong Duata, *Lam 2845* (L). SULA ISLANDS. North Mangoli, *bb 29789* (BO, L); Sanana, Kali Waj Gaj, *bb 28808* (BO). BURU. Balo, *bb 31353* (BO, L). **Cultivated.** JAVA. Bogor, Hort. Bot. *VII G 121* (BO), *VIII B 32* (L).

Artocarpus sericicarpus has not previously been distinguished from *A.*

[11] This specimen was examined by Mr. E. J. H. Corner, to whom I am indebted for information concerning the embryo.

elasticus, but it differs from the latter in characters of both the male and female inflorescences, notably in the very long and slender sterile processes on the syncarp. The specific epithet is derived from the appearance produced by the long hairs covering these processes. Sterile specimens can also be identified, since, although the leaves are sometimes slightly scabrid above, they are never short-hispid, as in *A. elasticus*. Their texture is usually more thinly coriaceous.

No very satisfactory specimen was available for selection as the type and the collection chosen consists of a shoot bearing young male and female inflorescences, and a detached leaf. It shows all the diagnostic characters with the exception of the length of the mature syncarp processes.

A collection of this species was sent to the Royal Botanic Gardens, Kew, by the Governor of British North Borneo in response to an enquiry about cloth made from *timbaran* bark, and was the subject of a note by Stapf (1894). In an accompanying letter it was stated that the specimen came from a species of *tarap*, of which there were three kinds used for making bark cloth, this being the best. Stapf concluded that it was very close to and probably a variety of *Artocarpus elasticus*. The vernacular name *timbaran* has not otherwise been recorded for this species, and is perhaps more correctly applied to *A. tamaran*. However, until *Artocarpus elasticus*, *A. sericicarpus* and *A. tamaran* have been clearly separated and studied in Borneo, their uses and correct native names cannot be stated with certainty.

21. **Artocarpus tamaran** Becc. For. Borneo, 626. 1902; Renner, Bot. Jahrb. 39: 366. 1907. Holotype, Sarawak, *Beccari PB 2996* (FI); isotypes (FI, L).

Trees, height to 40 m. *Twigs* 5–10 mm. thick, rugose, puberulent, with scattered patent rufous hairs (to 5 mm. long), denser at nodes; annulate stipular scars c. 0.5 mm. broad, slightly prominent; lenticels scattered. *Stipules* 3–9 cm. long, lanceolate, acute, villous, the hairs rufous, subappressed. *Leaves* 20–35 × 11–17 cm., ovate-elliptic, varying ovate, short-acuminate, base rounded, margin entire or shallowly crenate; juvenile leaves to 100 cm. long, deeply pinnatifid, the pinnae emarginate at the base and the midrib narrowly winged by lamina, to pinnate, the rachis not winged and the pinnae pinnatifid; main veins prominent beneath, intercostals slightly so; glabrous above, main veins beneath appressed-sericeous, midrib often also with longer, patent hairs, reticulum with sparse, short, appressed hairs; lateral veins (15–)17–23 pairs, straight; intercostals parallel; green, drying pale to dark red-brown; hypodermis of 2 or 3 cell-layers present, complete, cells isodiametric in surface view; gland-hairs slightly immersed, heads depressed-globose, 4-celled; petiole 35–40 mm. long.

Inflorescences solitary in leaf-axils. *At anthesis*: *male head* (immature) 70 × 10–14 mm., cylindric, the surface tuberculate with numerous irregular, cylindric, obtuse, solid processes c. 3 × 2 mm., entirely covered by flowers, apices of processes pilose with rufous hairs c. 2 mm. long borne on surface of axis; perianths tubular, 0.6 mm. long, bilobed above, minutely

pubescent; stamen (immature), filament broad, flattened, abruptly contracted above, anther-cells oblong, 0.2 mm. long; peduncle 35–55 × 3–5 mm., indumentum as twig; *female head* with simple styles exserted to 0.5 mm. *Syncarp* to 10 × 5 cm. (fide Beccari, to 14 × 8 cm. ? including processes), cylindric, drying dark brown, covered by closely set, fleshy processes of two lengths, the longer flexuous, filiform, solid, to 10 × 0.5 mm., the shorter conical, perforate, 3 × 1 mm., all rough from short, recurved hairs; wall c. 8 mm. thick; "seeds" (pericarps) numerous, ellipsoid, 6 × 4 mm.; core c. 12 mm. across; peduncle 55–100 × 6 mm. (–130 mm., fide Beccari), indumentum as twig.

VERNACULAR NAMES: *Tarap tempunan* (Malay); *Tamaran* (fide Beccari); *Tembaran.* USES: cloth is made from the bark.

DISTRIBUTION: In evergreen forest to 1800 ft., Borneo.

Borneo. SARAWAK. Kuching, M. Mattang, Vallombrosa, *Beccari PB 2996*, Dec. 1866 (FI, K, ♂, ♀). WEST BORNEO. Bukit Lempai, *Teysmann 7104* (BO, L); Melawie, Klepuk, B. Sanggau, *bb 29070* (A, BO, L). SOUTH AND SOUTHEAST BORNEO. Pleihari, Sungei Sangga, *bb 9944* (BO, L); Tanah Bumbu, Kampong Baru, *bb 13316, 13345* (BO, ♂, ♀). EAST AND NORTHEAST BORNEO. Balikpapan: Pemaluan, *bb 24760* (BO, L). E. Kutei: Pengadan, *bb 13024* (BO); Sg. Kerajaan, n. of Sangkulirang, *Kostermans 5853* (K, L, ♀). W. Kutei: Blu-u, *Jaheri 1498* (BO). Tidung: Sobediang, *bb 17869* (A, BO, ♀). BRITISH NORTH BORNEO. Sepilok For. Res., 15 mi. w. of Sandakan, *Wood SAN 16544* (A, L, ♂, ♀). Kabili-Sepilok For. Res., *Puasa Kepong FN 55241* (KEP). P. LAUT. Sungei Paring, *bb 13201* (BO).

Both the leaves and the inflorescences of *Artocarpus tamaran* are very distinctive. The appearance of the male head is somewhat remarkable, since the surface, which is completely covered by flowers, is produced into short, irregularly cylindric, solid projections, and the tips of these are pilose with hairs that are borne on the axis, between the flowers. The syncarp processes are smaller and more slender (to 10 × 0.5 mm.) than in either *Artocarpus elasticus* or *A. sericicarpus* and are covered by recurved hairs. The leaves have an unusually large number of lateral veins (17–23 pairs, as compared with 11–16 pairs in the two preceding species) and the form of the deeply pinnatifid juvenile leaves, with sessile pinnae, emarginate at the base, and a narrowly winged rachis, is unique in the genus.

22. **Artocarpus sumatranus** Jarrett, sp. nov. Holotype, Indragiri, *bb 22055* (BO); isotype (L).

Differt ab *A. kemando et A. maingayi* syncarpio processibus conicis obtecto, foliis subtus omnino tenuiter pubescentibus.

Arbores ad 25 m. altae. *Ramuli juniores* 2.5–3 mm. crassi, tenuiter rugosi, appresse hispidi-pubescentes; cicatrices stipularum annulatae, 0.5 mm. latae, parum prominentes, inconspicuae; lenticellae rarae. *Stipulae* 1–2 cm. longae, ovato-lanceolatae, acutae, appresse pubescentes, pilis rufis. *Folia* [6–]11–18 × [3–]5–10 cm., oblongo- vel obovato-elliptica, obtusa vel breviter obtuseque acuminata, basi rotunda vel cuneata, margine in-

tegra, supra glabra vel appresse puberulentia, subtus omnino tenuiter pubescentia, viridia, in sicco rufi-brunnea; costa nervi lateralesque subtus prominentes; nervi laterales utrinque c. 11, recti vel leviter curvati; nervi transversales paralleli, subtus prominuli; areolae, inter retem venularum, subtus parum bullatae; hypodermis strato duplico cellis superne isodiametricis composita; glandulae semi-immersae, capitibus depresso-globosis, 4-cellis; petiolus 10–30 mm. longus.

Inflorescentia axillis foliorum solitaria. [*Capitulum masculum* (immaturum) 26 × 5 mm., cylindricum, superficie rugosa, floribus numerossisimis obtecta; perianthia tubulosa, 0.6 mm. longa, clavata, supra bilobata, lobis crassis, minute pubescentia; stamina (immatura) cellis antherum ellipticis, 0.2 mm. longis; pedunculus 20 × 3 mm., appresse hispidi-pubescens.] *Syncarpium* (submaturum) 4 × 2 cm., cylindricum, in sicco rufi-brunneum, processibus crebris, carnosis, conicis, hispidi-pubescentibus, c. 1.5 × 1.5 mm., perforatis, stylis simplicibus 0.5 mm. longis exsertis, obtectum; pedunculus 35 × 3 mm., appresse hispidi-pubescens.

VERNACULAR NAME: *Pudu* (Malay).

DISTRIBUTION: In lowland evergreen forest, Sumatra (Indragiri, Lampongs).

Sumatra. INDRAGIRI. Kwala Keritang, *bb 28715* (BO, L); Selat Pandjang, Kamparmonding, *bb 22055*, Mar. 1937 (BO, L, ♀); Tempuling, *bb 10271* (BO, ♂). LAMPONGS. *Teysmann s.n.* (BO).

Artocarpus sumatranus resembles *A. kemando* and *A. maingayi* in the general size of its parts, and is distinguished from them primarily by the conical, rather than umbonate or truncate, processes on the syncarp of the holotype. Minor vegetative differences enable the single male and two sterile collections cited above to be associated with the type. The leaves are a little larger than in *A. kemando* or *A. maingayi* and, while they resemble the former in outline, they are obtuse or obtusely acuminate and thinly pubescent throughout beneath, instead of on the main veins only. The twigs are also slightly stouter. The male peduncle is longer than in either of the two following species, and the indumentum of the peduncles differs in being appressed, instead of patent (but *cf.* the anomalous collections discussed under *A. kemando*).

23. **Artocarpus kemando** Miq. Fl. Ind. Bat. Suppl. 418. 1861; Becc. For. Borneo, 628. 1902; Renner, Bot. Jahrb. **39**: 366. 1907; Ridley, Fl. Malay Penin. **5**: 335. 1925; Merr. Pl. Elmer. Born. 46. 1929; Burkill, Dict. 256. 1935; Corner, Gard. Bull. Singapore **10**: 282. 1939, Wayside Trees, 656. 1940. Holotype, Sumatra, *Teysmann HB 4515* (L); isotypes (BO, P, U).

Artocarpus brunneifolia S. Moore, Jour. Bot. **63**, Suppl. 112. 1925. Holotype, Sumatra, *Forbes 3046* (BM); isotypes (BO, GH, L, P).

Evergreen trees, height to 35 m. *Twigs* 2–2.5 mm. thick, finely rugose, shortly subappressed or appressed hispid-pubescent, hairs rufous; annulate

stipular scars c. 0.5 mm. broad, inconspicuous; lenticels few, scattered. *Stipules* 0.7–2 cm. long, lanceolate, acute, rufous appressed-pubescent. *Leaves* 5–15 × 2–6 cm., elliptic-oblong, varying elliptic, acute to acuminate, base rounded or cuneate, margin entire; juvenile leaves elongate; main veins prominent beneath; glabrous above, main veins beneath appressed-pubescent, surface between glabrous or nearly so; lateral veins 9–13 pairs, straight or slightly curved; intercostals parallel; deep green, drying red-brown or pale red-brown; hypodermis of 1–3 cell-layers present, cells isodiametric in surface view; gland-hairs superficial to half immersed, heads depressed-globose, 4-celled; petiole 10–20 mm. long.

Inflorescences solitary or paired in leaf-axils. *At anthesis*: *male head* 20–40 × 3–5 mm., cylindric, the surface rugose, covered by flowers; perianths deeply bilobed, 0.4 mm. long, short-pubescent; stamen 0.45 mm. long, filament cylindric, anther-cells ellipsoid, 0.2 mm. long; peduncle 7–13 × 2 mm., pubescent with short, patent hairs; *female head* with simple styles exserted to 0.5 mm. *Syncarp* to 4 × 2.5 cm., ellipsoid, drying brown, fleshy, covered by contiguous, low, umbonate processes, c. 2 mm. across, or the surface becoming nearly smooth and areolate, patent-pubescent with short, inflated hairs; wall c. 1 mm. thick; fruiting perianths several, proximal free region thin-walled, not fleshy, "seeds" (horny pericarps) subglobose, 8 × 5 mm., style sub-basal, testa fleshy, embryo subreniform, the long axis horizontal, concave below over the basal hilum with the radicle ventral, the cotyledons parallel to the median plane of the ovary, equal or one slightly shorter; core c. 5 mm. across; peduncle 15–40 × 3 mm., indumentum as male.

VERNACULAR NAMES: *Pudu* or *Kudu* (Malay), Malaya, Sumatra, Borneo.

DISTRIBUTION: In evergreen forest, often on swampy ground, to 500 (–1500) ft., southern Malaya, southeastern Sumatra, Banka, Billiton, Lingga Archipelago, Borneo.

Malaya. PAHANG. Temerloh, *Hamid CF 5171* (K, SING, ♂). JOHORE. Kangka Sedili Ketchil, *Corner s.n.*, June 1934 (SING); Mawai, S. Berassau, *Corner s.n.*, Feb. 1935 (SING); Mawai, S. Kayu, *Corner s.n.*, Feb. 1935 (SING). SINGAPORE. Bukit Timah, *Langlassé 288*, *303* (P), *Ridley 6432* (BM, SING, ♂, ♀); Jurong, 15th mile, *Corner s.n.*, Mar. 1933 (SING); Mandai road, *Kiah SFN 37716* (A, BM, BO, K, PNH, SING, ♀), *s.n.*, Aug. 1940 (SING, ♀); Seletar Forest, Nee Soon, *Sinclair SFN 40322* (L, SING); Reservoir Jungle, *Corner SFN 37000* (A, BM, BO, K, SING, ♂, ♀); Sungei Toas, *Goodenough 3378* (SING, ♀).

Sumatra. INDRAGIRI. Muara Serangge, *bb 30028* (BO, L, ♂); Pagarumbei, Tjenako River, *bb 25789* (A, BO, L); Sungei Akar, *bb 28629* (BO). DJAMBI. Muara Pidjuan, *bb 12275* (BO). PALEMBANG. *NIFS T 1191* (BO, L, U, ♂); Banjuasin and Kubustreken, *Grashoff 768* (BO); Banjuasin, Bajunglintjir, *NIFS T 755* (BO, L, SING, U, ♂, ♀), *1193* (BO, K, L, U, ♀); Lematang Ilir, Gunong Megang, *NIFS T 360* (BO, L, ♂, ♀), *837* (BO, K, L, U, ♂, ♀), *1205* (BO); Muara Mengkulem, R. Rawas, *Forbes 3046*, 1880 (BM, BO, GH, L, P, ♂, ♀). LAMPONGS. Kebang, *Teysmann HB 4515* (BO, L, P, U, ♂). BANKA. Blinju, *Grashoff 106* (BO, L, ♂); Toboali, *Teysmann HB 7244* (BO, L). BILLITON. *Teysmann HB 16727* (BO);

Tandjungpandan, *Teysmann s.n.* (BO); Tandjungpandan, Banlan, *bb 7268* (BO); Was, *Rossum 492* (BO, K, L, ♀). LINGGA ARCHIP. P. Sinkep, Ulu Santil, *bb 2002* (BO).

Borneo. SARAWAK. *Beccari PB 935* (K, P, ♀); near Kuching, *Beccari PB 2666* (C, K, P, ♀); Sungei Semengoh For. Res., Kuching, *Muas S 191* (SING). WEST BORNEO. Gunong Sangiang, *Romburgh 35* (BO, ♂); Melawie, Tjatil B. Tengkujung, *bb 26350* (BO, L); Melian, Dawak, *bb 12402* (BO); Sungei Landak, *Teysmann HB 11255* (BO, K, P, ♀), *11311* (BO, ♂); Sungei Tjabang, *Romburgh 16* (BO). SOUTH AND SOUTHEAST BORNEO. Beneden Dajak, Danau Rawah, *bb 13477* (BO); Beneden Dajak, near Peda Ketapi, *Meegan V* (BO); Muara Teweh, Nihan Dajak, *bb 10055* (BO); Pleihari, Djilatan, *bb 9900* (BO); Puruktjahu, Kalapeh, *bb 11082* (BO); Sampit, Natai Nangka, *bb 14072* (BO, ♂, ♀). EAST AND NORTHEAST BORNEO. Bulungan: Mara, *bb 10785* (BO). E. Kutei: Sg. Bambangan, s.e. of Samarinda, *Kostermans 6068* (A, L, ♀); Sg. Tiram, *bb 35033* (L); Tandjong Bangko region, near mouth of Mahakam River, *Kostermans 7190* (K, L, ♀). W. Kutei: Blu-u, *Jaheri 1499* (BO); Bukit Lajang, *bb 16242, 16254, 16260* (A, BO, L); near L. Djanean, *Endert 5065* (K, L, ♀); Longbleh, *bb 16154* (A, BO, L); Mujup, *bb 16731, 16762* (A, BO, L); Sebulu, *bb 15802, 15803* (BO); Tandjong Isui, *Endert 1952* (L). BRITISH NORTH BORNEO. Sabah For. District, Keningau, Agudon, *Angian 7721* (SARF, ♀); Tambunan, *Herb. For. Dept. B.N.B. 5252* (SING, ♀); Elphinstone Prov., Tawao, *Elmer 21511, 21780* (A, BM, BO, C, GH, K, L, P, SING, U, ♀).

Although it has been generally recognized that *Artocarpus kemando* and *A. maingayi* are closely related to each other, they have usually been treated as distinct species, Beccari (1902), reduced *A. maingayi*, from King's description, to synonymy under *A. kemando*. However, since King had not seen the latter species, he had been unable to differentiate *A. maingayi* from it clearly.

Corner, in 1939, listed the differences between the species in the shape of the leaves, the length and indumentum of the peduncles, and the surface markings and indumentum of the syncarps (given above in the key to the species). The puberulent upper surface of the immature leaves in *A. maingayi* is also a useful distinguishing character, since the hairs are often conspicuous against the dark red-brown dried leaves. This character, together with the leaf shape, usually enables even sterile collections to be assigned to one or the other of the species with certainty. Both Ridley (1925) and Corner (1940) suggested that *Artocarpus maingayi* could perhaps be treated as a variety of *A. kemando*, but it is felt that they are sufficiently distinct from each other to justify their maintenance at specific rank. The distributional areas of the two species are complementary, overlapping only in Johore; *A. maingayi* is found to the west and north, and *A. kemando* to the south and east, within western Malaysia (excluding Java).

Two anomalous collections, which do not agree in their characters with either species, must be noted here. The first of these is *Forbes 3046* from Palembang, Sumatra, which is cited above. This collection was described by S. Moore in 1925 as a new species, *Artocarpus brunneifolia*, which he distinguished from *A. maingayi* by the larger, glabrous leaves and the longer, glabrous peduncles. Apart from the velutinous syncarp, the male

perianths and the stipules, the specimen is nearly glabrous. The leaves resemble those of *A. kemando* in shape, but are rather large (to 19 × 7 cm.). The inflorescences are immature, but their measurements are within the range of variation of *A. kemando*, and the umbonate processes on the young syncarp agree with *A. kemando*, rather than with *A. sumatranus* or *A. maingayi*. The collection is probably from a juvenile shoot of *Artocarpus kemando*.

The second specimen is *Burkill & Haniff SFN 13843*, Grik, Perak, Malaya (SING, ♀). This was cited by Ridley (1925) as *Artocarpus kemando*, but the characters are somewhat intermediate between this species and *A. maingayi*. The young syncarp has the velutinous surface of *A. maingayi*, but the processes are umbonate, as in *A. kemando*, and the peduncle is 12 mm. long. The obovate-elliptic, short-acuminate leaves, which measure 7.5–12 × 3.5–5 cm. and are appressed-puberulent beneath, are not typical of either species, and the peduncle also differs from both in being appressed-pubescent.

24. **Artocarpus maingayi** King in Hook. f. Fl. Brit. Ind. **5**: 542. 1888, et in Ann. Bot. Gard. Calcutta **2**: 11. *t. 8A*. 1889; Renner, Bot. Jahrb. **39**: 366. 1907; Ridley, Fl. Malay Penin. **3**: 354. 1924; Corner, Gard. Bull. Singapore **10**: 282. 1939, Wayside Trees, 657. 1940. Syntypes, Malaya, Perak, *King 3595* (CAL, not seen), *6963* (CAL, not seen; duplicates examined, BM, K, L, P, SING), *Scortechini s.n.* (not seen; duplicate examined, K), Malacca, *Maingay 1481* (CAL, not seen).

Evergreen trees, height to 40 m. *Twigs* c. 2 mm. thick, finely rugose, shortly subappressed or appressed hispid-pubescent, hairs rufous; annulate stipular scars c. 0.5 mm. broad, inconspicuous; lenticels few, scattered. *Stipules* 0.7–2 cm. long, lanceolate, acute, rufous appressed-pubescent. *Leaves* 5–18 × 2.5–7.5 cm., obovate-elliptic, varying elliptic, shortly and obtusely acuminate to shallowly retuse, base rounded or cuneate, margin entire; main veins prominent beneath; glabrous above (young leaves appressed-puberulent), main veins beneath appressed-pubescent, surface between glabrous or nearly so; lateral veins 9–13 pairs, straight or slightly curved; intercostals parallel, irregular; deep green, drying red-brown (hairs on upper surface of young leaf conspicuous); hypodermis of 1–3 cell-layers present, cells isodiametric in surface view; gland-hairs superficial to half immersed, heads depressed-globose, 4-celled; petiole 10–20 mm. long.

Inflorescences solitary or paired in leaf-axils. *At anthesis*: *male head* 30–55 × 5–6 mm., cylindric, the surface rugose, covered by flowers; perianths deeply bilobed, 0.4 mm. long, short-pubescent; stamen 0.45 mm. long, filament cylindric, anther-cells ellipsoid, 0.2 mm. long; peduncle c. 5 × 2 mm., velutinous; *female head* with simple styles exserted to 0.5 mm. *Syncarp* to 4.5 × 2 cm., subellipsoid, drying brown, fleshy, tesselate with very low, truncate processes c. 2 mm. across, velutinous with inflated hairs; scattered bracts present between the processes, heads infundibuliform, c. 0.2 mm. across; peduncle 3–8 × 4 mm., velutinous.

DISTRIBUTION: In evergreen forest to 500 ft., western and southern Malaya, Sumatra (Atjeh, Tapanuli, West and East Coast), Simalur.

Malaya. PERAK. [*Scortechini*] *s.n.* (K, ♀); Larut, *King 6963*, Dec. 1884 (BM, K, L, P, SING, ♀). SELANGOR. *Murdoch 76* (BM); Kuala Lumpur, Carcosa, *Yeob CF 5702* (SING, ♀); Kuala Lumpur, Public Gardens, *Burkill SFN 6335* (SING, ♂), *Foxworthy CF 2359*, *Green s.n.*, Nov. 1941 (SING, ♀), *Hamid CF 4893* (K, SING, ♂, ♀), *Mat Soh CF 13826* (SING, ♀); Kuala Lumpur, Weld Hills Reserve, *Hamid CF 573* (SING, ♂, ♀), *4575* (K, SING). NEGRI SEMBILAN. Tampin, *Burkill SFN 3209* (K, SING, ♂, ♀). MALACCA. Sungei Udang, *Alvins 31* (SING). JOHORE. Ma'okil For. Res., Kluang, *Wyatt Kepong FN 71305* (K, ♂); Mawai-Jemalaung road, Sungei Kayu Ara, *Corner s.n.*, May 1935 (SING).

Sumatra. ATJEH. Gajolanden, Pendeng to Gadjah, *Van Steenis 9313* (L, ♀). TAPANULI. Barus, Pankalan Tapus, *bb 28400*, *29536* (A, BO, L, SING); Sibolga, Lapian, *bb 3809* (BO, L). WEST COAST. Ophir, Aer Bangis, *bb 19850* (A, BO, L); Ophir, Gadang, *bb 19477* (A, BO, L, SING); Painan, Duku, *bb 3107* (BO, L, SING, ♀), *3139* (BO, L). EAST COAST. Asahan, Simpang Toba, *bb 10438* (BO); Bengkalis, Sungei Missigit, *Beguin 572* (BO, L). SIMALUR. *Achmad 48* (BO, L, ♂, ♀), *1256* (BO, L, ♀); Lampang Aer, *bb 3036* (BO, L); Landschap Tapah, Defajan, *Achmad 1453* (BO, L, ♂, ♀), *1522* (BO, K, L, SING, ♀).

The three following species, *Artocarpus hirsutus*, *A. nobilis* and *A. sepicanus*, are placed at the end of section *Artocarpus* as being anomalous in their characters. In the discussion of the classification of the section (p. 132 above) it is pointed out that certain characters of these species, namely, the echinate syncarp in *A. hirsutus* and the presence of well-developed interfloral bracts in *A. nobilis* and *A. sepicanus*, are intermediate to those of sect. *Duricarpus*. Additional material, which has recently become available, shows that all three species also resemble sect. *Duricarpus* in the subapical position of the style.

25. **Artocarpus hirsutus** Lamarck, Encycl. Méth. **3**: 210. 1789, "*hirsuta*"; Roxb. Fl. Ind. **3**: 521. 1832; Wight, Ic. Ind. Or. **6**: *t. 1957*. 1853; Dalz. & Gibson, Bombay Fl. 244. 1861; Beddome, Fl. Sylvat. *t. 308*. 1873; King in Hook. f. Fl. Brit. Ind. **5**: 541. 1888; King, Ann. Bot. Gard. Calcutta **2**: 9. *t. 5*. 1889; Watt, Dict. Econ. Prod. Ind. **1**: 329. 1889; Dalgado, Fl. Goa, 179. 1898; Talbot, Trees Bombay ed. 2. 332. 1902, For. Fl. Bombay **2**: 527. *fig. 532*. 1908; Cooke, Fl. Bombay **2**: 656. 1907; Renner, Bot. Jahrb. **39**: 365. 1907; Bourdillon, For. Trees Travancore, 368. 1908; Troup, Silvicult. Ind. Trees **3**: 876. *fig. 323*. 1921; Fischer in Gamble, Fl. Madras **3**: 1369. 1928.

Ansjeli Rheede, Hort. Ind. Malab. 3: 25. *t. 32*. 1682.

Castanea Malabarica Angelina dicta Ray, Hist. Pl. 2: 1384. 1688.

Artocarpus pubescens Willd. Sp. Pl. ed. 4. 4: 189. 1805, nomen illegitimum; Persoon, Syn. Pl. 2: 531. 1807; Sprengel, Syst. Veg. ed. 16. 3: 804. 1826; Tréc. Ann. Sci. Nat. Bot. III. 8: 122. 1847.

Ficus malabarica Miq. Hooker Lond. Jour. Bot. 7: 457. 1848, receptaculis exclusis, quae sunt *Ficus palmata* Forskål, 1775; King, Ann. Bot. Gard. Calcutta 1: 182. 1888. Holotype, Madras, *Wight 873* (U).

Evergreen trees, height to c. 70 m., bark grey. *Twigs* 4–7 mm. thick, rugose, appressed-hispid, hairs yellow; annulate stipular scars c. 0.5 mm. across, not prominent; lenticels scattered. *Stipules* 1.5–2.5 cm. long, ovate-lanceolate, acute, densely appressed-hispid, hairs yellow. *Leaves* 10–25 × 5–15 cm., elliptic, rhomboid or ovate, short-acuminate, base rounded to cuneate, margin entire; juvenile leaves at least to 50 × 35 cm., pinnatifid, margin dentate towards apex; main veins prominent beneath, intercostals scarcely so; glabrous above or with scattered hairs on main veins, these appressed-pubescent beneath; lateral veins 10–13 pairs, straight; intercostals parallel; dark green, drying red-brown to blue-grey above, pale red-brown beneath; hypodermis absent; gland-hairs slightly immersed, heads depressed-globose, c. 6-celled; petiole 10–20 mm. long.

Inflorescences solitary or paired in leaf-axils. *At anthesis*: *male head* 70–160 × 5–7 mm. narrowly cylindric, smooth, covered by flowers; perianths tubular, 1.5 mm. long, bilobed above, sparsely pubescent; stamen 2.2 mm. long, filament slender, cylindric, anther-cells oblong, 0.3 mm. long; peduncle 20–40 × 2.5–4 mm., sub-appressed hispid-pubescent; *female head* with simple styles exserted to c. 1 mm. *Syncarp* to at least 5 × 4 cm. (the size of a lemon, fide Beddome, 1873), short-cylindric to ellipsoid, varying subglobose, yellow to orange, drying red-brown, echinate from closely set, rigid, cylindric, acute, hispid processes, 5–8 × 1 mm.; peduncle 45–65 × 4 mm., subappressed hispid-pubescent.

VERNACULAR NAMES: *Anjili* (Tamil), *Hebhalsina* (Kanarese), *Ran-* or *Pat-phunnas* (Malayalim). USES: the wood is very valuable for boat and house building and the species is planted as a timber tree.

DISTRIBUTION: From sea level to 4000 ft. in the evergreen forests of the Western Ghats, India.

India. Peninsular India, *Wight 2174* (K); Canara and Mysore, *Law s.n.* (K); Malabar and Concan, *Hooker f. & Thomson s.n.* (CAL, U), *Stocks, Law, etc. s.n.* (BM, GH, L, P, U, ♂, ♀); Malabar, *Buchanan s.n.* (BM, ♂, ♀), *Luck s.n.* (K), *Wight 948* (U); S. Malabar, Dhoni, *Ali 27* (CGE, ♂), *Jape 27* (K), *Tiga 53* (CGE, ♂, ♀); S. Malabar, Kalladikos, *Fischer 2620* (K, ♂, ♀); Ndipu [?], *Buchanan s.n.*, Feb. 1801 (BM, ♂). TRAVANCORE-COCHIN. Cooli Thora, *Lawson 266* (DD, K, ♂, ♀). MADRAS. S. Canara, *Beddome 7520* (BM); e. of Goa boundary, Manchikeri, *Fernandes 1585* (A, ♀); Madura, Sirumalais, *Bourne 1813* (K); near Mangalore, *Hohenacker 455* (P), *Wight 2715* (C, GH, K, P, ♂, ♀); Mercara, *Wall 455* (U); Nilgiris, *Johnson s.n.*, Dec. 1850 (K, ♂); Nilgiris, Gudalier, *Gamble 15496* (K); Nilgiris, Nadiwatam, *Gamble 18262* (K); Tenkasi, Courtallen, *Wight 873* (U). MYSORE. Bababoodun Hills, *Law s.n.* (K, ♂, ♀). BOMBAY. *Law s.n.* (K, ♂, ♀); Concan, *Law s.n.* (K); Concan, Sanklu [= Sangli], *Stocks, Law & Dalzell s.n.* (K, ♂, ♀); Kala Nuddi, *Ritchie 1377* (GH, K).

Lamarck's description of *Artocarpus hirsutus* was based on Rheede's account, under the vernacular name *Ansjeli*, which may be identified with certainty as referring to this species.

Beddome stated (1873) that the florets on the male head were intermixed with numerous chaffy scales, but he apparently was referring to the rather long hairs found on the surface of the receptacle between the flowers, which

are all that are shown in the analyses on his plate. King (1889) also mentioned chaffy scales, but the linear "receptacular scales" that he included in his illustration appear to be aborted florets. A careful examination has been made of the male inflorescences, and neither interfloral bracts nor sterile flowers — apart from a few of the latter that failed to develop fully — have been found.

In considering the characters of *Artocarpus hirsutus* (p. 132 above), with a view to placing it in the most "natural" position within subgenus *Artocarpus*, it is stated that the internal structure of the mature syncarp is not known. Since the publication of this section of the paper a collection has become available with what are probably the fruiting perianths of this species, containing mature pericarps. This collection, *Fernandes 1585*, which is cited above, consists of a sheet bearing some sterile shoots of *Artocarpus hirsutus* and three packets. The first packet contains fragments of the syncarp wall of *A. hirsutus* and a few fruiting perianths, with a note, "skin & seeds of wild Jackfruit." The second contains numerous mature, indurated endocarps which are sufficiently different in detail (shape and appearance of testa) to be referable without doubt to a different species. There is a note, "seeds of wild Jackfruit 10 inch × 5 inch = 80 seeds were counted." From the field label the endocarps appear to be from a fallen fruit. The only other species of *Artocarpus* found wild in the area is *Artocarpus* (subg. *Pseudojaca*) *gomezianus* (represented by a subspecies to be described in the following paper) and, although only submature syncarps have been seen of this entity, the characters of the "seeds" are in fairly good agreement with those of the endocarps on *Fernandes 1585*. The dimensions given of the fruit are also apparently erroneous and may refer to the jackfruit, since some seeds of this are preserved in the third packet.

The identity of this fruiting material cannot yet be regarded as fully established, but, in the absence of any other information, a description of the fruiting perianths and the enclosed structures is given: proximal free region thick-walled (? fleshy — somewhat decayed), "seeds" (pericarps with an indurated endocarp not separated from the thin exocarp), ovoid, 15 × 8 mm., style subapical, testa thick, reddish-purple, indurated, embryo with the radicle apical, the cotyledons equal, longitudinal, at an angle of c. 45° to the median plane of the ovary. If these perianths are correctly assigned to *Artocarpus hirsutus*, as seems likely, the characters of the embryo suggest that the species should be assigned to a new series in sect. *Duricarpus*. The species would agree with the other members of the section in most of the characters of the syncarp, but would differ in the shape of the male head and in the absence of interfloral bracts from the inflorescences.

26. **Artocarpus nobilis** Thwaites, Enum. Pl. Zeylan. 262. 1861; Beddome, Fl. Sylvat. *t. 309*. 1873; Trimen, Cat. Pl. Ceylon, 85. 1885; King in Hook. f. Fl. Brit. Ind. **5**: 542; King, Ann. Bot. Gard. Calcutta **2**: 12. *t. 10*. 1889; Watt, Dict. Econ. Prod. Ind. **1**: 333. 1889; Trimen, Handb. Fl. Ceylon **4**: 98. 1898; Willis, Cat. Pl. Ceylon, 84.

1911; Macmillan, Trop. Pl. & Gard. ed. 4. 250. 1935; Abeyes. & Rosayro, Checklist Ceylon, 49. 1939. Holotype, Ceylon, *Thwaites CP 2818* (PDA, not seen); isotypes (BM, C, GH, K, P).

Artocarpus pubescens auct. non Willd., Moon, Cat. Pl. Ceylon, 61. 1821.

Evergreen trees, height to 20 m. *Twigs* 10–12 mm. thick, rugose, shortly appressed-hispid; annulate stipular scars c. 1 mm. broad, not or slightly prominent; lenticels mostly in a ring below scar. *Stipules* 3–12 cm. long, oblong-lanceolate, shortly and densely appressed-hispid, hairs yellow. *Leaves* 14–32 × 8–23 cm., ovate, short-acuminate, base broadly rounded to broadly cuneate, margin inrolled, crenate or crenate-sinuate between the lateral veins; juvenile leaves pinnatifid; main veins prominent beneath, intercostals slightly so; young leaves slightly scabrid on both surfaces from minute appressed hairs, becoming smooth; lateral veins 10–13 pairs, straight; intercostals parallel; green, drying red-brown, paler beneath; hypodermis absent; gland-hairs sunken, heads flattened, 8-celled; petiole 18–25 mm. long.

Inflorescences solitary or paired in leaf-axils. *At anthesis*: *male head* 70–130 × 15 mm., cylindric, smooth, covered by flowers and bracts; perianths tubular, 1.3 mm. long, shortly bilobed above, minutely pubescent; stamen 1.8 mm. long, filament slender, cylindric, anther-cells globose, 0.2 mm. long; bracts rather stoutly stalked, heads peltate, to 0.6 mm. across, ciliate; peduncle 30–70 × 3 mm., indumentum as twig; *female head* with the surface nearly covered by peltate heads of bracts, to 0.5 mm. across, and simple styles exserted to 0.7 mm. between them. *Syncarp* to 20 × 10 cm., cylindric, drying black, covered by closely set, rigid, short-cylindric, obtuse, puberulent processes, 1 × 1–1.5 mm.; numerous peltate bracts persistent between processes; wall c. 2 mm. thick; fruiting perianths numerous, proximal free region thin-walled, not fleshy, "seeds" (pergamentaceous pericarps) obovoid, 8 × 7 mm., style subapical, testa horny, embryo with the radicle ventral, the cotyledons parallel to the median plane of the ovary, equal; core c. 12 mm. across; peduncle 110–150 × 6–8 mm., indumentum as twig.

VERNACULAR NAMES: *Del* or *Bedi-del* (Sinhalese). USES: the timber is valuable and the seeds are eaten roasted.

DISTRIBUTION: Endemic in evergreen forest up to c. 2000 ft. in the wetter parts of Ceylon.

Ceylon. *Koenig s.n.* (BM, C), *Oltmans 109*, *Rouin s.n.* (L), *Thwaites 2818* (BM, C, GH, K, P, ♂, ♀), *sine nom. 15* (L); Kandy, Hillcrest, *Worthington 6749* (CGE, ♂, ♀). (Fide Thwaites, 1861, not uncommon in the southern and central regions of the island.)

Artocarpus nobilis is the only species of the genus in which the margin of the adult leaf is more or less regularly crenate, although a shallowly crenate margin is found in some specimens, probably taken from juvenile shoots or from the lower branches of mature trees, of several other species. Koenig's specimens bear an apparently unpublished epithet under *Sitodium*.

27. **Artocarpus sepicanus** Diels, Bot. Jahrb. 67: 176. 1935, "*sepicana*." Holotype, northeastern New Guinea, *Ledermann 10628* (B).

Trees, height to 40 m., bark yellow-brown, peeling off in flakes. *Twigs* 3–5 mm. thick, scarcely to acutely rugose, glabrous; annulate stipular scars c. 0.5 mm. broad, not or slightly prominent; lenticels scattered. *Stipules* 1–3 cm. long, ovate, acute, glabrous. *Leaves* 8–30 × 4–12 cm., ovate-elliptic, ovate- or obovate-oblong or elliptic, short-acuminate, base usually oblique and half cordate, varying subequal and shallowly cordate, glabrous, margin entire or shallowly crenate; juvenile leaves to 40 × 16 cm., margin shallowly and regularly crenate; main veins prominent beneath, intercostals slightly so; lateral veins 9–16 pairs, straight; intercostals parallel; mid-green with pale yellow main veins, drying pale brown or the upper surface greyish; hypodermis absent; gland-hairs superficial, heads globose, 6–8-celled; petiole 10–25 mm. long.

Inflorescences solitary in leaf-axils. *Male head* (nearly at anthesis) c. 20–30 × 5–7 mm., cylindric, smooth, covered by perianths and bracts; perianths 2 (or 3)-fid to half their length, 0.8 mm. long, minutely pubescent; stamen, filament cylindric, anther-cells oblong, 0.4 mm. long; bracts rather stoutly stalked, heads peltate, to 0.8 mm. across, short-ciliate; peduncle c. 15–30 × 1–1.5 mm., glabrous. *Female head* (at anthesis) with bifid styles exserted to 1.5 mm. *Syncarp* (submature) to 4.5 × 1.5 cm., cylindric, green, drying light brown, the surface areolate with closely set, fleshy, very short, truncate, velutinous processes, to 0.5 × 2 mm., polygonal in surface view, (?) becoming nearly smooth; numerous bracts persistent between processes, heads peltate, to 1 mm. across; peduncle c. 25–45 × 2.5 mm., glabrous.

DISTRIBUTION: In evergreen forest to 600 ft., endemic to New Guinea.

New Guinea. VOGELKOP. Bomberai: K. Wermudena, *bb 22493* (BO, L). Manokwari: Momi, *bb 33418* (BO, K, L); Oransbari, *Brouwer BW 2513* (L); Warnapi, 15 km. from Ransiki, *Kostermans 409* (BO, L). DUTCH NORTH NEW GUINEA. Hollandia: *Schram BW 2761* (K, L, ♂, ♀); Berap, Nimburan, *bb 28906* (BO, L, ♂); Mamberamogebiet, Pioneerbivak, *bb 31101* (BO, L); Tami, *Brouwer BW 771, 782* (L). DUTCH SOUTH NEW GUINEA. Mimika, Aria, Uta, *bb 32861* (L). PAPUA. Central Division: Port Moresby, Mt. Lawas Timber Reserve, Rubulogo Creek, *Jackson NGF 4520* (K, L, SING). MANDATED TERRITORY OF NEW GUINEA. Madang District: Ramu Valley c. 5 miles se. Faita airstrip, *Saunders 181* (L). Morobe District: Lae, *NGF 694* (L, ♂). Sepik District: Malu, *Ledermann 10628*, Jan. 1913 (B, ♀); Sepik River, near Yellow River, *Womersley NGF 3785, 3871* (A, BO, K, L, SING, ♂).

The material of *Artocarpus sepicanus* which is at present available is inadequate for a complete description of the inflorescences. The internal structure of the submature syncarp of *Schram BW 7261* has been examined since the introductory portion of this paper was published and may be described as follows: wall c. 1 mm. thick; proximal region of perianths thin-walled, not fleshy, free only near the base, partly matured ovaries ellipsoid, laterally compressed, to 4 mm. long including the short stalk,

pergamentaceous but somewhat indurated above the hilum, style subapical, hilum about halfway down the ventral face, testa (empty) membranaceous, with the conspicuous micropyle at the apex of the ovary, and the chalaza at the base; core c. 5 mm. across. The rather wide separation of the subapical style and the ventral hilum is unusual in *Artocarpus* but is found to a marked degree in the mature ovary of *Prainea papuana*.

Although several of the collections cited are sterile, they can be identified by the characteristic foliage. The leaves are somewhat similar to those of *A. teysmannii*, which also occurs in western New Guinea, but may be distinguished by the narrower outline, the less smooth appearance, and the oblique or shallowly cordate base.

ARTIFICIAL KEYS TO THE SPECIES OF ARTOCARPUS SUBGENUS ARTOCARPUS

Key to Specimens bearing Male Inflorescences

1. Head with the surface largely covered by the peltate heads of numerous bracts.
  2. Head cylindric, length/breadth = 4–10.
    3. Head c. 2–3 × 0.5–0.7 cm. .... 27. *A. sepicanus.*
    3. Head 7–13 × 1.5 cm. .... 26. *A. nobilis.*
  2. Head globose to clavate or short-cylindric, length/breadth = 1–3.5(–4).
    4. Twigs and leaves glabrous.
      5. Leaves pinnate. .... 1. *A. anisophyllus.*
      5. Leaves simple. .... 2. *A. lanceifolius.*
    4. Twigs and leaves (at least on the main veins beneath) hispid or hispid-pubescent.
      6. Peduncle to 0.6 cm. .... 7. *A. rigidus.*
      6. Peduncle 0.8–7.5 cm.
        7. Peduncle and twigs with patent hairs.
          8. Head 1.5–3 × 1.5–2 cm.; peduncle 1.2–3 cm. .... 6. *A. hispidus.*
          8. Head 4–9 × 2.5–3.5 cm.; peduncle 2.5–7 cm. .... 5. *A. odoratissimus.*
        7. Peduncle and twigs with appressed hairs.
          9. Leaves smooth above, hispid-pubescent on the main veins only beneath; perianths 1 mm. long, deeply 2(or 3)-lobed; peduncle 0.8–5 × 0.3 cm. .... 3. *A. melinoxylus.*
          9. Leaves scabrid above, hispid-pubescent throughout beneath; perianths 2 mm. long, shortly bilobed; peduncle 6–7.5 × c. 0.15 cm. .... 4. *A. chaplasha.*
1. Head with bracts few or entirely lacking, cylindric, varying ellipsoid or clavate, length/breadth = (1.5–)4–20.
  10. Surface of head smooth.
    11. Numerous filiform or clavate processes present between flowers and projecting 1–2 mm. from surface.
      12. Head 0.5–1 cm. across; adult leaves entire. 17. *A. teysmannii.*
      12. Head c. 2 cm. across; adult leaves deeply pinnatifid. .... 13. *A. multifidus.*

11. Projecting processes absent or a few scarcely emergent.
    13. Lateral veins of leaf 6–10 pairs, curved.
        14. Peduncle and twigs glabrous; head with a basal annulus formed by the enlargement of the peduncle into a flange to 3 mm. wide; base of leaf decurrent onto petiole. .... 15. *A. heterophyllus.*
        14. Peduncle and twigs pilose with patent, flexuous, rufous hairs c. 3 mm. long, varying glabrous; head without a basal annulus; base of leaf abrupt. ...... 14. *A. integer.*
    13. Lateral veins of leaf 10–25 pairs, straight.
        15. Peduncle densely appressed-hispid; head 7–16 × 0.5–0.7 cm. .... 25. *A. hirsutus.*
        15. Peduncle not as above.
            16. Peduncle and twigs pungent with patent, rigid, rufous, acicular hairs, c. 2 mm. long. ...... 10. *A. horridus.*
            16. Peduncle and twigs not as above.
                17. Peduncle with subpatent, recurved hairs, hooked at the tips; head 2–2.5 × 0.5 cm. .. 16. *A. lowii.*
                17. Peduncle not as above.
                    18. Head c. 0.7 cm. across; anthers 0.3–0.5 mm. long. .... 9. *A. treculianus.*
                    18. Head more than 1 cm. across; anthers 0.6–1.2 mm. long.
                        19. Anthers 1.2 mm. long; adult leaves deeply pinnatifid, lobes 12–20 pairs. ... . 12. *A. pinnatisectus.*
                        19. Anthers 0.6–0.8 mm. long; adult leaves entire to pinnatifid, lobes to 5(–9) pairs.
                            20. Scattered bracts usually present (appearing as tufts of hairs on the surface); perianth lobes with deflexed, inflated hairs; leaves pubescent beneath with straight or slightly undulate hairs. .. 8. *A. blancoi.*
                            20. Bracts absent; perianth lobes sparsely pubescent to glabrous; leaves (in the Philippines) subglabrous beneath, except the main veins, or pubescent, frequently with uncinate hairs. .... 11. *A. communis.*

10. Surface of head variously rugose.
    21. Head 6–20 × 1–2.5 cm.; peduncle 3.5–10 cm.; twigs 0.5–2 cm. thick.
        22. Head tuberculate with obtuse processes c. 3 × 2 mm., the apices pilose, hairs rufous, c. 2 mm. long. .... 21. *A. tamaran.*
        22. Head rugose-sulcate to subtuberculate, not pilose.
            23. Head subtuberculate, perianths with crisped hairs. .... 20. *A. sericicarpus.*
            23. Head rugose-sulcate; perianths without crisped hairs.
                24. Head 6.5–10.5 × 1 cm., shallowly sulcate; leaves smooth above, or nearly so. ...... 18. *A. scortechinii.*

24. Head 6–20 × 1.5–2.5 cm., deeply sulcate; leaves scabrid above. .... 19. *A. elasticus.*

21. Head 2–5.5 × 0.3–0.6 cm.; peduncle 0.5–2 cm.; twigs 0.2–0.3 cm. thick.

25. Peduncle c. 2 cm., hairs appressed; leaves subappressed-pubescent throughout beneath. .... 22. *A. sumatranus.*

25. Peduncle to 1.3 cm., hairs patent; leaves usually appressed-pubescent on main veins only beneath.

26. Peduncle c. 0.5 cm., velutinous; leaves obovate-elliptic varying elliptic, shortly and obtusely acuminate to retuse, young leaves appressed-puberulent above. 24. *A. maingayi.*

26. Peduncle 0.7–1.3 cm., pubescent; leaves elliptic-oblong varying elliptic, acute to acuminate, glabrous above. .... 23. *A. kemando.*

Key to Specimens bearing Female Inflorescences [12]

1. Processes covering the syncarp markedly dimorphic, the longer ones solid, flexuous, the shorter perforate, with styles exserted at anthesis.

2. Solid processes few, to 4 mm. long; syncarp to c. 8.5 × 2.5 cm. .... 17. *A. teysmannii.*

2. Solid processes numerous, longer.

3. Adult leaves deeply pinnatifid; solid processes c. 15 × 1 mm., rough from stout, recurved hairs, the longer ones crisped. . . 13. *A. multifidus.*

3. Adult leaves entire.

4. Leaves shortly appressed-hispid above; solid processes 10–18 × 1–1.5 mm., shortly patent-hispid. .... 19. *A. elasticus.*

4. Leaves smooth or nearly so above.

5. Lateral veins 11–16 pairs; solid processes 20–35 × 0.5–1 mm., subappressed-pubescent, hairs c. 2 mm. long. 20. *A. sericicarpus.*

5. Lateral veins 15–23 pairs; solid processes c. 10 × 0.5 mm., rough from short, recurved hairs. .... 21. *A. tamaran.*

1. Processes (or areolae) covering the syncarp all alike, perforate, with styles exserted at anthesis.

6. Syncarp 15–100 × 10–50 cm., fruiting perianths thick-walled, fleshy; cauliflorous; adult leaves entire.

7. Syncarp with a basal annulus formed by the enlargement of the top of the peduncle into a flange to 5 mm. wide (sometimes obscure); peduncle and twigs glabrous; base of leaf decurrent onto petiole. .... 15. *A. heterophyllus.*

7. Syncarp without a basal annulus; peduncle and twigs pilose with patent, rufous hairs c. 3 mm. long, varying glabrous; base of leaf abrupt. .... 14. *A. integer.*

6. Syncarp smaller, or fruiting perianths thin-walled or lacking (seeds not developed); not cauliflorous.

8. Syncarp cylindric, to 20 × 10 cm., the surface covered with short-cylindric, obtuse, indurated processes, 1 × 1–1.5 mm., numerous peltate bracts persistent between them, the heads to 0.5 mm. across. .... 26. *A. nobilis.*

[12] The measurements given are those of the mature syncarp but the key has been drawn up, as far as is practicable, so that it can be used for female inflorescences at any stage from anthesis to maturity.

8. Syncarp not as above.
  9. Syncarp globose to short-cylindric, length/breadth = 1–1.5, the surface armoured with indurated processes; pericarp with the style apical; embryo symmetrical, the radicle apical.
    10. Processes broadly cylindric, 1–4 × 1–3 mm., surface of the syncarp ± tesselate.
      11. Processes pubescent; twigs and leaves glabrous. .... 2. *A. lanceifolius.*
      11. Processes hispid; twigs and leaves (at least on the main veins beneath) hispid or hispid-pubescent.
        12. Processes with usually patent, slightly crisped hairs; leaves smooth above, hispid-pubescent on the main veins only beneath; male peduncle 0.8–5 × 0.3 cm. .... 3. *A. melinoxylus.*
        12. Processes with appressed hairs; leaves scabrid above, hispid-pubescent throughout beneath; male peduncle 6–7.5 × c. 0.15 cm. .... 4. *A. chaplasha.*
    10. Processes narrowly cylindric or tapering, 5–13 × 1–1.5 mm., surface of the syncarp ± echinate.
      13. Processes glabrous; adult leaves pinnate. .... 1. *A. anisophyllus.*
      13. Processes hispid; adult leaves entire.
        14. Processes 8–13 × 1 mm., apices clavate. .... 5. *A. odoratissimus.*
        14. Processes 5–9 × 1–1.5 mm., apices acute to obtuse.
          15. Peduncle 4.5–6.5 cm.; male head narrowly cylindric, 7–16 × 0.5–0.7 cm. ...... 25. *A. hirsutus.*
          15. Peduncle to 3.5 cm.; male head globose to obovoid, 1.3–3 × 1.3–2 cm.
            16. Peduncle and twigs with patent hairs; leaves elliptic to obovate-elliptic, scabrid above, base cuneate; male peduncle 1.2–3 cm. .... 6. *A. hispidus.*
            16. Peduncle and twigs with ± appressed hairs; leaves not as above (smooth above and/or base rounded); male peduncle to 0.6 cm. .... 7. *A. rigidus.*
  9. Syncarp cylindric or ellipsoid, rarely subglobose, length/breadth = 1–4, the surface covered by fleshy processes or merely areolate; pericarp with the style lateral to sub-basal (apical in *A. sepicanus*); embryo often asymmetrical, the radical ventral to sub-basal.
    17. Syncarp more than 10 cm. across, covered by attenuate or conical processes to 15 mm. long, varying to low facets or areolae, cultivars often seedless. .... 11. *A. communis.*
    17. Syncarp less than 10 cm. across.
      18. Twigs to 3 mm. thick, hispid-pubescent; syncarp to 5 × 3 cm.
        19. Syncarp with conical processes; peduncle appressed-hispid-pubescent. .... 22. *A. sumatranus.*
        19. Syncarp with umbonate or truncate processes, or the surface merely areolate.
          20. Syncarp patent-pubescent, with low, umbonate

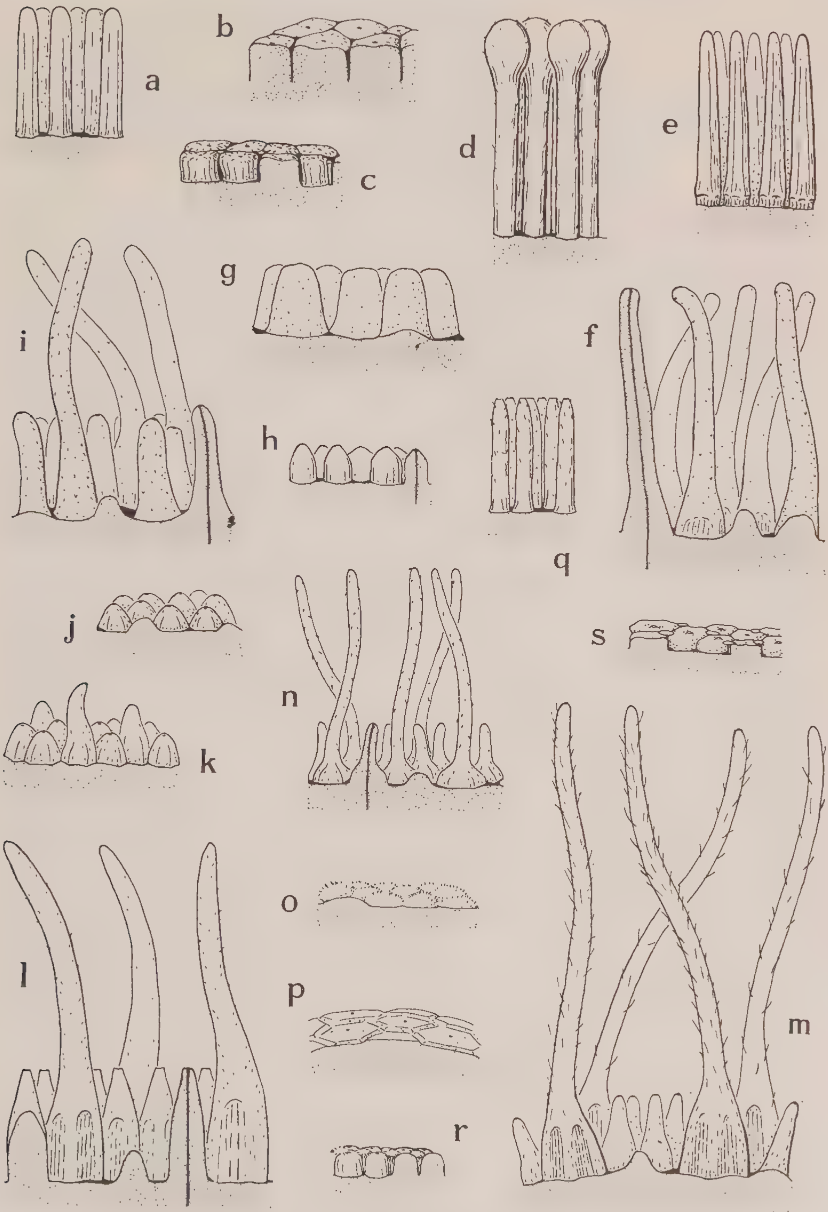

FIG. 16. The surface of the syncarp in *Artocarpus* subg. *Artocarpus*. a, *A. anisophyllus*; b, *A. lanceifolius*; c, *A. melinoxylus*; d, *A. odoratissimus*; e, *A. rigidus*; f, *A. blancoi*; g, *A. treculianus*; h, *A. horridus*; i, *A. multifidus*; j, *A. lowii*; k, *A. teysmannii*; l, *A. elasticus*; m, *A. sericicarpus*; n, *A. tamaran*; o, *A. kemando*; p, *A. maingayi*; q, *A. hirsutus*; r, *A. nobilis*; s, *A. sepicanus* (all approx. $\times 2\frac{1}{2}$).

processes or the surface merely areolate; peduncle 1.5–4 cm., patent-pubescent. . . . . 23. *A. kemando.*

20. Syncarp velutinous, tesselate with very low, truncate processes; peduncle to 0.8 cm., velutinous. . . . . 24. *A. maingayi.*

18. Twigs stouter, or glabrous to puberulent.

21. Syncarp processes with inflated hairs, usually rough from their deflexed tips, and/or the twigs with rigid, patent, acicular hairs.

22. Leaves deeply pinnatifid, with 12–20 pairs of lateral lobes; syncarp at least 15 × 5 cm., styles simple. . . . . 12. *A. pinnatisectus.*

22. Leaves entire or pinnatifid, with up to 5(–9) pairs of lateral lobes; syncarp smaller, styles bifid.

23. Peduncle and twigs pungent with rigid, patent, acicular hairs, c. 2 mm. long; syncarp processes c. 3 × 1.5–3 mm., varying glabrous. . . . . 10. *A. horridus.*

23. Peduncle and twigs villous to glabrous; syncarp processes never glabrous.

24. Processes 2.5–4 × 2.5–3 mm., bracts absent. . . . . 9. *A. treculianus.*

24. Processes 8–15 × 1.5 mm., scattered bracts usually present. 8. *A. blancoi.*

21. Syncarp processes (or areolae) without inflated hairs; twigs without acicular hairs.

25. Twigs 8–15 mm. thick; syncarp to at least 8.5 × 5.5 cm., covered by short-cylindric, obtuse or truncate, hispid-pubescent processes c. 3 × 2 mm. . . . . 18. *A. scortechinii.*

25. Twigs to 6 mm. thick; syncarp smaller, surface not as above.

26. Syncarp with numerous peltate bracts, the heads to 1 mm. across, the surface areolate with very short, truncate, velutinous processes, (?) becoming nearly smooth. . . . . 27. *A. sepicanus.*

26. Syncarp without peltate bracts.

27. Syncarp processes conical, or with the apices depressed at maturity and the surface hence areolate; peduncle 3.5–5.5 cm., with scattered, subpatent, recurved hairs, hooked at the tips; leaves elliptic, lateral veins 11–16 pairs. . . . . 16. *A. lowii.*

27. Syncarp processes conical at maturity; peduncle 3–10 cm., without patent hairs; leaves ovate to ovate-elliptic, lateral veins 6–12 pairs. . . . . 17. *A. teysmannii.*

THE GENERA OF OLEACEAE IN THE SOUTHEASTERN UNITED STATES

KENNETH A. WILSON AND CARROLL E. WOOD, JR.

THE OLEACEAE generally have been regarded as a natural family, but there seems to be no such agreement about their position within the sympetalous dicotyledons. Usually, however, the family is treated either as the sole member of the order Oleales or as constituting suborder Oleineae of the Gentianales (Contortae), aberrant within the order especially in the reduction of the stamens to two. The former view has been held by Wettstein, Rendle, and recently by Benson (who would, in addition, divide the Gentianales), the latter by Bentham and Hooker, Engler, Engler and Diels, Engler and Gilg, and (most recently) Cronquist, among others. Hutchinson has taken a more extreme position, splitting the Gentianales into three orders and aligning the Oleaceae with the Loganiaceae in his Loganiales. These varying viewpoints reflect both the perplexing similarities and the uncertainties of the interrelationships of the Oleaceae, Loganiaceae (including Buddlejaceae), Gentianaceae (including Menyanthaceae), Apocynaceae and Asclepiadaceae, the families usually grouped together here.

Although the questions of the ordinal position of the Oleaceae and of the interrelationships of many of the sympetalous families obviously require further consideration, our purpose here, beyond merely noting these problems, is to present data from a different level in the form of treatments of the genera of the Oleaceae as they occur in the southeastern United States, thus making some of the information concerning this interesting family more readily and immediately available. These treatments are a part of a biologically oriented generic flora which is being prepared for the southeastern United States as a joint effort of the Arnold Arboretum and the Gray Herbarium made possible through the interest and support of George R. Cooley and through a grant from the National Science Foundation. This paper follows the format and scheme set forth in the preceding papers and outlined in the first publication in the series.[1] As in the previously published papers, the descriptions are based upon the species of each genus which occur within the area bounded by and including North Carolina and Tennessee, on the north, and Arkansas and Louisiana, on the west; additional characters and supplementary information based upon other species are placed in brackets when included in the description. The abbreviations used in the citation of periodicals follow the general principles set forth by Lazella Schwarten and H. W. Rickett (Bull. Torrey Bot. Club **76**: 277–300. 1958). References which are included but which have not

[1] The previous papers in this series were published in Jour. Arnold Arb. **39**: 296–346. 1958 (woody Ranales); **40**: 94–112. 1959 (Nymphaeaceae and Ceratophyllaceae), 161–171 (Empetraceae and Diapensiaceae), 268–288 (Primulales).

been checked are followed by an asterisk (*). Annotations, when included, follow each reference and are inclosed by brackets. We are much indebted to many of our friends and colleagues in connection with all of this work on the flora of the southeastern United States. In connection with the Oleaceae, in particular, we are grateful to George R. Cooley for material of *Osmanthus* from the sand-pine scrub of central Florida.

OLEACEAE (Olive Family)

Trees or shrubs, sometimes climbing, with opposite, seldom alternate, simple or pinnately compound leaves, without stipules. Flowers regular, bisexual, rarely unisexual (the plants then dioecious or polygamous). Calyx 4(rarely more)-lobed, rarely wanting. Corolla 4(rarely more)-lobed, petals rarely almost free or wanting; aestivation imbricate or valvate, rarely contorted. Stamens 2 (rarely 3 or 4), epipetalous, alternate with the corolla lobes, the anthers dehiscing longitudinally, the pollen usually 3(4)-colpate. Pistil solitary, of 2 carpels, the style 1 or wanting, the stigma 2-lobed or simple, the ovary superior, 2-loculed, each locule with 2 (rarely 1–4) pendulous and anatropous, or ascending and amphitropous, ovules. Fruit a berry, drupe, capsule or samara. Seed with a straight embryo, the endosperm oily or wanting.

A family of 22–30 genera and over 400 species of the temperate and tropical regions of the world, but centered primarily in Asia and Malaysia. In our area it is represented by seven genera, three of which (*Syringa*, *Ligustrum*, *Jasminum*) were introduced as ornamentals but have since become established in our flora.

The family is distinguished by the usually four-parted perianth, the two epipetalous stamens, the two-loculed superior ovary, and the usually opposite, exstipulate leaves. On the basis of the position of the ovule and seed and the nature of the fruit, the family is divided into two subfamilies and three tribes. More recent cytological and morphological studies have resulted in a reclassification of the genera of the two subfamilies into seven tribes (cf. Johnson). Cytologically, the family may be divided into two groups: (1) genera with base chromosome-numbers of 11, 13, and 14; and (2) genera with base chromosome-numbers of 23 and 24. The 23-chromosome group corresponds largely to those genera placed in the subfamily Oleoideae and presumably represents a natural group. It has been postulated that the members of this group had a common origin from an allopolyploid ancestor. On the other hand, the genera with 11, 13, or 14 chromosomes form a heterogeneous assemblage corresponding roughly to the subfamily Jasminoideae, but including also *Forsythia* and *Fontanesia*, of the Oleoideae. The family is in need of very thorough cytological and morphological study of the species in order to establish clearer and more natural generic lines and subfamily groupings.

The family is best represented in our area in cultivation, where, in addition to species belonging to our native or naturalized genera, it also includes

species of *Fontanesia*, *Abeliophyllum*, *Forsythia*, *Phillyrea*, and *Osmarea* (*Phillyrea* × *Osmanthus*).

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KEY TO THE GENERA OF OLEACEAE

A. Flowers apetalous.
- B. Leaves pinnate; fruit a samara. .... 1. *Fraxinus*.
- B. Leaves simple; fruit drupaceous. .... 4. *Forestiera*.

A. Flowers with a distinct corolla.
- C. Corolla with elongate, nearly separate petals (united only at the base), white; fruit drupaceous. .... 5. *Chionanthus*.
- C. Corolla evidently sympetalous, with a distinct tube.
  - D. Flowers unisexual or bisexual, the plants dioecious or polygamous; fruit a drupe. .... 3. *Osmanthus*.
  - D. Flowers bisexual.
    - E. Fruit a capsule, persistent; flowers usually lilac to purple, rarely white. .... 2. *Syringa*.
    - E. Fruit a berry persisting only a few months; flowers white or yellow.
      - F. Corolla less than 1 cm. long, white, 4-lobed; fruit a 2-loculed berry with membranous to stony endocarp, not 2-lobed. .... 6. *Ligustrum*.
      - F. Corolla more than 1 cm. long, white or yellow, 4–9-lobed; fruit a 2-lobed berry (1 lobe sometimes aborting). .... 7. *Jasminum*.

Subfam. OLEOIDEAE Knobl.
Tribe FRAXINEAE Endl.

1. **Fraxinus** L. Sp. Pl. **2**: 1057. 1753; Gen. Pl. ed. 5. 477. 1754.

Deciduous trees, rarely shrubs; leaves opposite, pinnately compound [or rarely simple]. Plants dioecious, polygamo-dioecious, or monoecious.

Inflorescences axillary on the branches of the preceding year, clustered or in panicles. Flowers apetalous [or petals 2–6], the calyx small, 4-parted, or wanting. Staminate flowers with 2 (rarely 3 or 4) stamens, the anthers oblong or linear, 4-loculed, dehiscing longitudinally. Pistillate flowers with 0–2 abortive stamens, the pistil with a single style, the stigma 2-lobed, the ovary with 2 pendulous ovules in each locule. Flowers perfect in *F. quadrangulata*. Fruit a 1(2)-seeded, flattened or terete samara. TYPE SPECIES: *Fraxinus excelsior* L. (*Fraxinus*, the ancient Latin name of the ash.) — ASH.

A genus of about 65 species in two sections and seven subsections, chiefly of the temperate regions of the Northern Hemisphere, centered primarily in North America, eastern Asia, and the Mediterranean region, but also extending southward into the tropics in the West Indies, Mexico, and Malaysia. The 12 species (recognized by Miller) of the United States and Canada, fall into sect. FRAXINUS, with the exception of *Fraxinus cuspidata* Torrey, of the southwestern United States, which is a member of sect. ORNUS (a group of about 26 species, chiefly of eastern Asia, with inflorescences terminal on leafy shoots). The seven species of our area belong to two subsections of sect. FRAXINUS.

Section FRAXINUS (§ *Fraxinaster* DC.), with axillary inflorescences on the branches of the preceding year, includes five subsections, four of which occur in the United States and two in our area.

Subsection FRAXINUS (subsect. *Bumelioides* Endl.), with flowers bearing a deciduous calyx, has about 15 species centered in the Mediterranean region, extending westward to central Asia. One species (*F. nigra* Marsh.) occurs in northeastern North America and in northeastern Asia (var. *mandschurica* (Rupr.) Lingelsh.). A single species, *F. quadrangulata* Michx., the blue ash, with 4-angled twigs, enters our region, ranging from Ontario, Michigan and Wisconsin, to Alabama, Arkansas and Oklahoma, in dry or moist, rich woods.

Subsection MELIOIDES Endl., with asepalous flowers, includes about 13 species of Central America, Mexico, the United States and Canada — five of which occur in our area — and two of central Asia. Our species of this subsection fall into two complexes distinguished primarily by the presence of papillae on the lower epidermis of the leaflets ("white ash complex") or by the absence of these papillae ("red ash complex"). Specific lines within the genus are difficult to define because of both genetic and ecological variation, as well as the difficulties resulting from hybridization and polyploidy. The distinctions between the various species have been based on the number, size, shape, margin, and pubescence of the leaflets; the shape of the leaf scars and of the terminal and lateral buds; and the size and shape of the samaras.

Fraxinus americana L. ($2n = 46, 92, 138$), the white ash, which occurs in rich woods from Minnesota to Quebec, to Nova Scotia, New England, Florida and Texas, is very variable in its leaf shape. Tests of various populations of this species indicate that it is composed of at least three ecotypes

which differ primarily in their resistance to cold damage but also in the pubescence of the leaves. The "southern" ecotype, which ranges from Maryland to southern Indiana and southward, has pubescent leaves with reddish petioles and midribs, and suffers severely from cold damage. Both the "northern" and "intermediate" ecotypes are more resistant to winter-killing and have leaves which are somewhat less pubescent.

Fraxinus pennsylvanica (including *F. Darlingtonii* Britton, *F. Michauxii* Britton, and *F. Smallii* Britton) ($2n = 46$), the red ash, which occurs in low woods and on stream banks from Quebec to Saskatchewan, south to Florida and Texas, is also variable in the shape and texture of the leaf, and in the shape of the samaras. Progeny tests indicate that named varieties based on pubescence do not merit taxonomic recognition since pubescent seedlings may be obtained from either pubescent or glabrous parents. Three ecotypes similar to those of *F. americana* have also been described for this species (Wright). *Fraxinus pennsylvanica* differs from *F. americana* in the papillose condition of the lower epidermis of the leaflets, in the shape of the leaf scars, in the shape of the terminal and lateral buds, and in the diameter of the samaras. The two ashes are also ecologically distinct, *F. pennsylvanica* occurring in low elevations often in the vicinity of lakes and streams, and *F. americana* occurring in higher elevations; only occasionally do the two come in contact.

The status of *Fraxinus biltmoreana* Beadle, the Biltmore ash, is in need of further investigation. It has been interpreted both as a result of the rare hybridization of *F. pennsylvanica* and *F. americana*, and as a pubescent variety of the latter (var. *biltmoreana* (Beadle) J. Wright ex Fern.).

Fraxinus caroliniana Mill. (including *F. pauciflora* Nutt.), the water ash, is a shrubby tree of the swamps and lowlands of the coastal plain from Florida to Texas, northward to Virginia. Although a number of variants based on leaf pubescence and samara shape have been named, and at least one (*F. pauciflora* Nutt.) has been given specific rank, it would appear that this species is merely extremely variable.

Fraxinus tomentosa Michx. f. (*F. profunda* Bush) ($2n = 138$), the pumpkin ash, of bottom lands from Florida to Louisiana, northward to New York, Ohio, Indiana, southern Illinois, and Missouri, is a species of very questionable status. It is not clearly differentiated from *F. pennsylvanica*, and is identifiable only by average measurements of a group of characters including the length and width of the leaflets, length and width of the samaras, and length of the stomata, styles and ovaries, all of which are greater in *F. tomentosa* than in *F. pennsylvanica*. Breeding experiments are needed in *F. tomentosa* to determine whether it is an autopolyploid of *F. pennsylvanica* or is of hybrid origin.

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Tribe SYRINGEAE G. Don

2. Syringa L. Sp. Pl. 1: 9. 1753; Gen. Pl. ed. 5. 9. 1758.

Deciduous shrubs or small trees; leaves opposite, simple. Inflorescences terminal or lateral panicles. Flowers bisexual. Calyx campanulate, 4-toothed. Corolla salverform, 4-lobed. Stamens 2, included or exserted. Pistil with a single style, the stigma 2-lobed, the ovary with 2 pendulous ovules in each locule. Fruit a loculicidal capsule with 2 seeds in each locule. TYPE SPECIES: *Syringa vulgaris* L. (The name from the Greek *syrinx*, a

pipe, originally applied to the genus *Philadelphus*[1] from the use of its branches for pipes, later transferred to this genus.) — LILAC.

A genus of about 28 species in two subgenera centered in western China, ranging east and north to Korea and northern Japan, and west and south to Tibet, Afghanistan, and the northwestern Himalaya. Two species occur in Europe in the Balkan peninsula (*S. vulgaris* and *S. Josikaea* Jacq.). The genus is represented in our flora by *S. vulgaris* which escapes sparingly from cultivation or persists in old plantings.

More than 20 species of *Syringa* are grown as ornamentals in gardens throughout the temperate world. By far the most popular species is *S. vulgaris*, represented by over 500 cultivars which have been developed by selection, cross-pollination of garden forms, or by the propagation of sports. Many of the older cultivars have already disappeared from gardens, but several hundred are still popular today.

Species of subg. SYRINGA do not hybridize with those of subg. LIGUSTRINA (Rupr.) K. Koch. Moreover, within subg. SYRINGA no hybrids have been obtained from crosses between species of different series, with the notable exception of ser. *Pinnatifoliae* Rehder, closely allied to ser. *Syringa* (ser. *Vulgares* Rehder). Both series were maintained, nevertheless, on morphological grounds in spite of the genetic compatibility between the two. Within each series there is a considerable amount of genetic compatibility, and many hybrids have been developed, often of great horticultural value, although many are sterile or lack vigor. More than 14 hybrids and their numerous cultivars, mostly in ser. *Syringa*, are in cultivation.

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Tribe OLEINEAE Endl.

3. **Osmanthus** Lour. Fl. Cochinchin. 1: 28. 1790.

Evergreen shrubs or small trees; leaves opposite, simple, entire. Inflorescences axillary or terminal, cymes or panicles. Flowers bisexual or unisexual in various combinations, the plants dioecious, [monoecious, polygamous, or bearing only bisexual flowers]. Calyx 4-parted. Corolla imbricate, 4-parted, usually with a short tube. Stamens 2 (rarely 4), included. Pistil with a single style, the stigma capitate, entire (or 2-lobed), the ovary with 2 pendulous, anatropous ovules in each locule. Fruit a 1-seeded drupe. (Including *Cartrema* Raf., *Amarolea* Small.) TYPE SPECIES: *O. fragrans* (Thunb.) Lour. (The name from the Greek *osme*, fragrance, and *anthos*, flower, in reference to the fragrant flowers.) — WILD OLIVE, DEVILWOOD.

A genus of more than 30 species in at least four sections, primarily of eastern and southeastern Asia, but extending into Polynesia, with two to four species in North America and one or two species native to our area.

Osmanthus americanus (L.) Gray, with dark purple, ellipsoid, ovoid or subglobose fruits with stones pointed at both ends or only at the base, occurs in a variety of habitats (rich woods, hammocks, wooded bluffs, sand scrubs) from Florida to Louisiana, north to southeastern Virginia, and also in Mexico. The leaves are variable in texture and shape, the fruit in shape and size, and the inflorescence in length and compactness.

At least three variants of *O. americanus* have been described from peninsular Florida. *Osmanthus megacarpus* (Small) Small ex Little, from the sand hills of Highlands County at the southern end of the Lake Region, has very much larger, globose fruit, but the range in the fruit-size overlaps that of *O. americanus*. Purported differences in the stone are of no significance, since similar shapes occur in *O. americanus*; the two are otherwise very similar. On these bases the large-fruited plant has been treated as *O. americanus* var. *megacarpus* (Small) P. S. Green. *Osmanthus floridanus* Chapm., from "sandy pine barrens, Manatee, South Florida," was said to differ from *O. americanus* in having yellowish-green fruit and pubescent inflorescences. An additional possible species was postulated by Small in a plant from the northeastern coastal region with small, globose fruit, and a stone scarcely pointed at the base. The total variation is striking, particularly in Florida, but whether species based primarily on such differences in the fruit are valid is very problematic. A study, especially in the field, of population variations in leaves, fruits, and inflorescences, correlated with habitat differences, is much needed.

Osmanthus is equally puzzling in Mexico where *O. americanus* var. *americanus* occurs in Oaxaca and Veracruz, and a small-leaved plant with compact inflorescences, var. *microphyllus* P. S. Green, is known from two collections from Nuevo León. *Osmanthus mexicanus* Lundell, with elliptic to oblanceolate, acuminate leaves, is known only from the type collection from Chiapas and appears to fall within the range of variation of *O. americanus*.

The American species of *Osmanthus* belong to sect. LEIOLEA (Spach) P. S. Green (inflorescence paniculate, corollas small and of thin texture) which otherwise includes about seven species of tropical and subtropical eastern Asia. The American species have also been treated as a separate genus, *Cartrema* Raf. (*Amarolea* Small), particularly on the basis of the more elaborately branched inflorescence. *Osmanthus americanus* is a hexaploid ($2n = 138$), while four other species (Asiatic and none belonging to this section) are diploids ($2n = 46$). The problem of the generic status of the American species deserves further study, taking into account all of the other species of *Osmanthus* and those of closely related genera, including *Linociera*, *Notelaea*, *Olea*, *Phillyrea*, and *Steganthus* (cf. Green).

The remaining three sections are Asiatic. Section OSMANTHUS is represented in our area only in cultivation, most notably by the very fragrant *O. heterophyllus* (G. Don) P. S. Green (*O. ilicifolius* (Hassk.) Mouillef.), $2n = 46$, and *O. fragrans* (Thunb.) Lour., $2n = 46$, the latter not hardy much to the north. *Osmanthus* × *Fortunei* Carr. is a hybrid of these two species. The species of the Pacific area present a particularly perplexing

problem in the structure of their flowers and inflorescences. These may represent either a separate section or may constitute an independent genus (*Gymnelaea* (Endl.) Spach; cf. L. A. S. Johnson).

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4. **Forestiera** Poir. Encycl. Méth. Suppl. **1:** 32. 1810; **2:** 664. 1811 [1812].

Deciduous or rarely evergreen shrubs; leaves opposite simple, entire or serrate, short-petioled. Plants dioecious or polygamo-dioecious. Inflorescences axillary on the branches of the preceding year, the flowers clustered or in short racemes. Flowers apetalous, calyx minute, 4-parted or irregularly toothed, fugacious, or occasionally wanting. Staminate flowers mostly sessile, stamens 1–4, anthers oblong, 4-loculed, opening longitudinally, pistil wanting or rudimentary. Pistillate flowers on short, 1–3-flowered peduncles; abortive stamens 0–4; pistil with a slender style, the stigma simple or 2-lobed, the ovary with 2 pendulous ovules in each locule. Fruit a 1(rarely 2)-seeded black or dark-blue drupe. (*Adelia* P. Browne, nom. rejic., not L., nom. cons. [Euphorbiaceae]; *Borya* Willd., not Labill.) Type species: *Forestiera cassinoides* (Willd.) Poir. (*Borya cassinoides* Willd. = *Adelia cassinoides* (Willd.) O. Ktze.). (The name in honor of Charles Le Forestier, physician and naturalist during the early 1800's.)

A genus of perhaps 20 species ranging from Brazil northward through Mexico and the West Indies to the United States. The plants occurring in our area have been interpreted as representing three to six species.

The differences in interpretation of the species of this genus point to the lack of understanding of the biology of the group. The species have been distinguished on the basis of the time of flowering (i.e., before or after the leaves expand), the shape of the leaves, the shape of the fruit, the cutting of the leaf margin, the presence or absence of pubescence, and the persistence of the leaves. Additional information, particularly that based on field observation, is essential in this genus, and data on ecological variation, as well as any evidence of hybridization or introgression, should be accumulated.

The two most widely distributed species occurring in our area are *Forestiera acuminata* (Michx.) Poir., which ranges from Florida to Texas, northward to South Carolina, Tennessee, Illinois, Missouri, and Kansas

on river banks, in swamps and in hammocks, and *F. ligustrina* (Michx.) Poir., ranging from Florida to Texas, Georgia, Tennessee, and Kentucky, on rocky soils, sand dunes and in pinelands. *Forestiera segregata* (Jacq.) Krug & Urban (including *F. porulosa* (Michx.) Poir.) occurs in hammocks, marshes and low pinelands and ranges from the West Indies northward to Florida and Georgia (cf. Johnston).

Forestiera acuminata and *F. neo-mexicana* Gray have both been reported to have a diploid chromosome number of 46.

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5. **Chionanthus** L. Sp. Pl. 1: 8. 1753; Gen. Pl. ed. 5. 9. 1754.

Deciduous shrubs or low trees; leaves opposite, simple, entire, petioled. Inflorescences loose, drooping panicles, from the axillary buds near the end of the year-old branches. Plants polygamo-dioecious. Calyx 4(rarely 5)-parted. Petals white, narrow, linear, united at the base. Stamens 2 (rarely 3 or 4), short, on the base of the corolla, the anthers apiculate, 4-loculed. Pistil with a short style, the stigma 2-lobed, the ovary with 2 ovules in each locule. Fruit a 1(seldom 2)-seeded dark-blue, ovoid drupe. TYPE SPECIES: *Chionanthus virginicus* L. (The name from the Greek *chion*, snow, and *anthos*, flower, in allusion to the abundant white flowers.) — FRINGE-TREE, OLD-MAN'S-BEARD.

A genus of three or four species, two in eastern North America and one or two in eastern Asia. Both American species are native in our area, and *Chionanthus retusus* Lindl. & Paxt. (China, Korea, Japan) may be found in cultivation. *Chionanthus virginicus* L. ($2n = 46$), a tall shrub or tree to 10 m. in height, the flowers with acuminate anthers and petals 2–3 cm. long, occurs in swampy or damp woods, or on stream banks, or in much drier, rocky soils with *Pinus*, *Quercus* and *Carya*, ranging from Florida to Texas, northward to New Jersey, Pennsylvania, West Virginia, southern Ohio, southern Missouri, and Oklahoma. It is also widely cultivated. *Chionanthus pygmaeus* Small, a small shrub to 40 cm. in height spreading by underground stems, the flowers with blunt-tipped anthers and petals about 1 cm. long, is an endemic of the sand-scrub in the lake region of central Florida.

Differences in the pubescence and shape of the leaves, the size of the flowers and the length of the petals are apparent between the more northern

plants of *Chionanthus virginicus* and those of peninsular Florida. The significance of the variation in this species is as yet obscure.

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6. **Ligustrum** L. Sp. Pl. 1: 7. 1753; Gen. Pl. ed. 5. 8. 1754.

Deciduous or evergreen shrubs or small trees; leaves opposite, simple, entire. Inflorescences terminal panicles. Flowers white, bisexual. Calyx campanulate, 4(or irregularly)-toothed. Corolla funnelform, 4-lobed, the lobes as long as the tube or much shorter. Stamens 2, inserted on the tube of the corolla, included or exserted. Pistil with a single style, the stigma 2-lobed, the ovary with 2 pendulous, anatropous ovules in each locule. Fruit a 1–4-seeded berry with membranous to stony endocarp; [fruit dehiscent in *L. sempervirens*]. TYPE SPECIES: *L. vulgare* L. (*Ligustrum*, the classical name of *L. vulgare*.) — PRIVET.

A genus of about 30 species in three sections, chiefly of eastern Asia and Malaysia to Australia, one species (*L. vulgare* L.) in Europe and North Africa. A number of species are widely cultivated as ornamental shrubs for their foliage and attractive small, white flowers. The species represented in our flora are all escapes from cultivation; others in cultivation may also be expected to escape.

The most widely cultivated and best-known species is *Ligustrum vulgare* L. ($2n = 46$), sect. LIGUSTRUM (sect. *Baccatae* Mansf.) (endocarp membranous, seeds 2–4), which has become widely naturalized in thickets and open woods throughout much of eastern North America.

Section SARCOCARPION (Franch.) Mansf. (endocarp dehiscent, seed 1) consists of a single species, *L. sempervirens* (Franch.) Linglesh. from western China, which is now sparingly cultivated and probably not at all represented in our area.

All other species of the genus belong to sect. SUBDRUPACEA Mansf. ("Subdrupaceae") and at least three have become established in our area. *Ligustrum ovalifolium* Hassk. is extensively naturalized along roadsides and in disturbed areas on the coastal plain and in the piedmont from Virginia southward. Plants identified as *Ligustrum sinense* Lour. have become established in North Carolina, South Carolina, Alabama, and Louisiana, where they may grow in large stands which, when in flower, saturate the area with an unpleasant, penetrating odor. Some question exists with respect to the taxonomy and nomenclature of this plant, but the solution

must await a study of the Chinese species of the genus. Reports of *Ligustrum amurense* Carr. in southeastern Virginia apparently are based on fruiting material only; these specimens seem to be identical with our *L. sinense*, but flowering material is needed to verify this identification. *Ligustrum lucidum* Ait. ($2n = 46$), and *L. obtusifolium* Sieb. & Zucc. ($2n = 46$) have been reported in scattered localities from eastern Pennsylvania, Virginia, or North Carolina southward. *Ligustrum Quihoui* Carr., which is cultivated in the Southeast, has been reported as an escape in northern Virginia and may well occur elsewhere. Conscientious collecting is very much needed to determine the present distribution and future spread of these Asiatic species. Key characters are based primarily on flowering specimens, but fruiting specimens should also be collected whenever possible.

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Subfam. JASMINOIDEAE Knobl.
Tribe JASMINEAE R. Br.

7. **Jasminum** L. Sp. Pl. 1: 7. 1753; Gen. Pl. ed. 5. 7. 1754.

Deciduous or evergreen, erect or climbing shrubs; leaves opposite or alternate, simple or pinnately compound. Inflorescences terminal or axillary on year-old branches, cymose (flowers rarely solitary). Flowers bisexual. Calyx campanulate or funnelform, 4–9-lobed, the lobes of varying length. Corolla yellow or white, [pink or red,] salverform, 4–9-lobed, the tube

cylindrical. Stamens 2, included. Pistil with a single style, the stigma 2-lobed, the ovary 2-loculed, each locule with 1–4 amphitropous and ascending, or seldom anatropous and pendulous, ovules. Fruit a 2-lobed berry, each locule with 1 or 2 seeds, 1 of the 2 carpels often failing to develop. TYPE SPECIES: *J. officinale* L. (*Jasminum*, the latinized Arabic name.) — JASMINE.

A genus of about 200 species in four sections, chiefly tropical and subtropical, occurring in eastern and southern Asia, Malaysia, Africa, and Australia, with a single species (*J. lanceolatum* Ruiz & Pav.) in tropical America (Peru). Many species are widely cultivated as garden ornamentals, and several have escaped from cultivation and have become naturalized in tropical and subtropical areas. Although poorly represented in herbaria, at least four species are known to be established in the flora of our area.

Section ALTERNIFOLIA DC. (leaves alternate, simple or compound or both) is represented in our area only in cultivation by *J. humile* L. ($2n$ = 26), from eastern Asia, and perhaps others.

Section TRIFOLIOLATA DC. (leaves opposite, trifoliolate) includes *J. Mesnyi* Hance ($2n$ = 24, 26), from western China, an evergreen, rambling shrub with bright yellow, often double, flowers and a foliaceous calyx, which has been reported to have escaped cultivation in Georgia. *Jasminum azoricum* L., from the Canary Islands, an evergreen climber with white flowers, has become established in Key West. In addition to these, *J. nudiflorum* Lindl. ($2n$ = 52), from China, a shrub with arching branches and one of the hardiest species, is widely grown for its bright yellow flowers which appear in earliest spring.

Section UNIFOLIOLATA DC. (leaves opposite, simple) is represented by *J. Sambac* (L.) Ait. ($2n$ = 26, 39) and *J. amplexicaule* Wallich ex Don (= *J. undulatum* Kerr.), both of which have become established in woods and thickets in Florida. At least *J. gracillimum* Hook. ($2n$ = 26) and *J. multiflorum* (Burm. f.) Andr. ($2n$ = 26, 39) are also in cultivation.

Section JASMINUM (§ *Pinnatifolia* DC.) (leaves opposite, five-foliolate or more) includes *J. officinale* L. forma *grandiflorum* (L.) Kobuski ($2n$ = 26), a deciduous shrub with large, white flowers, which is known both in cultivation and as an escape in pinelands and thickets in southern Florida.

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A REVISED KEY TO THE CHINESE SPECIES OF JASMINUM

Clarence E. Kobuski

Recently, while identifying a series of Chinese specimens of the genus *Jasminum*, I realized that a dozen or more taxa had been added since my earlier synopsis (Jour. Arnold Arb. **12**: 145. 1932) of the genus in China. In this first paper no new species were described. However, nearly half of the names already published were reduced to synonymy.

Since then three papers have been published by me, all of them devoted to the descriptions of new taxa or changes in nomenclature. These papers are: (1) "A new *Jasminum* from Hainan," published in Sunyatsenia **3**: 110. 1936; (2) "New and noteworthy species of Asiatic *Jasminum*," in Jour. Arnold Arb. **20**: 64. 1939; and (3) "Further notes on *Jasminum*," also in Jour. Arnold Arb. **20**: 403. 1939. Twenty taxa were described as new or changed in status in these three publications.

Other papers were published on *Jasminum* in China during this period; one, which was overlooked by me at the time, was by Hayata, Ic. Pl. Formosa, **9**: 70. 1920. In this paper a new species, *J. shimadai*, was described from Formosa. At first I was surprised that I had overlooked this paper but finally realized that in 1932, when I wrote the synopsis, Formosa was not considered as part of China but was associated with Japan. The Japanese botanists working on the flora of the island at that time related their works with the Japanese rather than the Chinese flora. The description and illustration by Hayata show that this taxon is a synonym of the very variable and widely distributed *J. lanceolarium* Roxb.

In 1933, Gagnepain, in his paper "Oleacées nouvelles d'Indochine" (Bull. Soc. Bot. France, **80**: 70, 74. 1933) oddly enough included two new Chinese species, *J. fuchsiaefolium* and *J. pinfaensis*. In his description of the former the author noted that the corolla was unknown and the fruit immature which makes it difficult to include in a key. The latter species, *J. pinfaense*, although not seen by me, is surely new and has been incorporated in the key using the description for characters.

Finally, Handel-Mazzetti, Symb. Sin. 7 ^{2}: 1012. 1936, described a new form, *J. lanceolarium* f. *unifoliolatum*, a surprising association, since *J. lanceolarium* belongs to the series *Trifoliolata* and the described form undoubtedly belongs to the series *Unifoliolata*. The very brief description consists of only two words, "*Folio unifoliolata*." I could understand the placing of this taxon with *J. lanceolarium* were there both trifoliolate and unifoliolate leaves present such as are found in *J. forrestianum*, but Handel-Mazzetti merely states that the specimen had four pairs of unifoliolate leaves. Probably, the specimen either belongs to an already described species in the unifoliolate series or represents a new species. No material is available to me at this time.

At the suggestion of some of my colleagues I have revised my earlier key to include most of the new additions. Probably other species have since been described by Chinese botanists but their works to a great extent are not available at present for comparison and study.

Further to assist workers in this group a list of accepted taxa and synonyms is given following the key.

KEY TO THE SERIES

A. Leaves alternately arranged. . . . . 1. *Alternifolia.*
A. Leaves opposite in arrangement.
  B. Leaves compound.
    C. Leaves trifoliolate. . . . . 2. *Trifoliolata.*
    C. Leaves five-foliolate or more. . . . . 3. *Pinnatifolia.*
  B. Leaves simple. . . . . 4. *Unifoliolata.*

Series 1. ALTERNIFOLIA DC.

A. Calyx-teeth subulate-setaceous, longer than calyx-tube.
  B. Leaves and plant glabrous. . . . . *J. floridum.*
  B. Leaves puberulous. . . . . *J. giraldii.*
A. Calyx-lobes diminutive or obtuse, shorter than calyx-tube.
  B. Leaves both simple and ternate; leaflets 5–8 cm. long; inflorescence 30–50-flowered, the corymbs 7–12 cm. across.
    C. Calyx-lobes and pedicels glabrous. . . . . *J. diversifolium* var. *glabricymosum.*
    C. Calyx-lobes and pedicels villous. . . . *J. diversifolium* var. *subhumile.*
  B. Leaves ternate or pinnate; leaflets 1.5–3.5 cm. long; inflorescence 3–8-flowered. . . . . *J. humile.*

Series 2. TRIFOLIOLATA DC.

A. Calyx-lobes foliaceous.
  B. Leaves persistent, coriaceous, present at time of flowering. . . . *J. mesnyi.*
  B. Leaves deciduous; flowers appearing before leaves.
    C. Plants erect or scandent; simply branched.
      D. Leaves uniformly green. . . . . *J. nudiflorum.*
      D. Leaves variegated or some entirely yellow. . . . . *J. nudiflorum* f. *aureum.*
    C. Plants pulvinate; intricately ramose. . . . *J. nudiflorum* var. *pulvinatum.*
A. Calyx-lobes quite vestigial or subulate when present.
  B. Leaves palmately trinerved.
    C. Leaves and branchlets glabrous. *J. urophyllum.*
    C. Leaves and branchlets puberulent. . . . . . *J. urophyllum* var. *wilsonii.*
  B. Leaves pinnately veined.
    C. Leaves and branchlets glabrous.
      D. Terminal leaflet same size or only slightly larger than the lateral leaflets, the veining obscure. . . . . *J. lanceolarium.*
      D. Terminal leaflet more than twice as large as the lateral leaflets, the veining pronounced, especially on the lower surface. . . . . *J. forrestianum.*

C. Leaves and branchlets pubescent.
D. Calyx-lobes vestigial; leaves and branchlets puberulent. .... *J. lanceolarium* var. *puberulum.*
D. Calyx-lobes subulate-setaceous; leaves and branchlets pilose.
E. Corolla-tube up to 4 cm. long; lateral leaflets petiolulate, smaller than the terminal leaflet but up to 6 cm. long. .... *J. sinense.*
E. Corolla-tube ca. 2 cm. long; lateral leaflets sessile, ca. 1 cm. long, about one-tenth the length of the terminal leaflet. .... *J. anisophyllum.*

Series 3. PINNATIFOLIA DC.

A. Calyx-lobes subulate-setaceous, 5–8 mm. long.
B. Flowers white. .... *J. officinale.*
B. Flowers pink. .... *J. stephanense.*
A. Calyx-lobes usually obtuse or, if subulate, not more than 1 mm. long.
B. Leaflets distinctly trinerved. .... *J. polyanthum.*
B. Leaflets five-nerved. .... *J. dispermum.*

Series 4. UNIFOLIOLATA DC.

A. Calyx-lobes diminutive, obtuse, not subulate-setaceous.
B. Corolla * 35 mm. long (in toto), the tube 25 mm. long; leaves 10–26 cm. long, 6–10 cm. wide.
C. Inflorescence a subsessile, axillary cyme, with ca. 10 flowers. .... *J. coffeinum.*
C. Inflorescence an axillary panicle or raceme (sometimes terminal), many-flowered.
D. Veins at an acute angle, arching gracefully upward; inflorescence an axillary or terminal raceme. .... *J. wangii.*
D. Veins at an obtuse angle, nearly perpendicular to midrib, rather straight, arching only slightly; inflorescence an axillary panicle. .... *J. robustifolium.*
B. Corolla ca. 25 mm. or less in length; leaves seldom over 4 cm. wide, usually considerably less.
C. Inflorescence terminal, a many-flowered, diffuse cyme up to 10 cm. wide; corolla-tube and lobes (linear) nearly equal. ...... *J. seguinii.*
C. Inflorescence terminal and axillary, the flowers usually in close clusters; corolla-tube considerably longer than the lobes (acute).
D. Leaves usually 9–16 cm. long, 3–4 cm. wide, lanceolate or oblong-lanceolate; Western China (Yunnan). .... *J. duclouxii.*
D. Leaves 3.5–8.5 cm. long, 1.5–4 cm. wide, ovate; Eastern China (Kwangtung). .... *J. microcalyx.*
A. Calyx-lobes subulate-setaceous.
B. Calyx-tube glabrous.
C. Leaves coriaceous.
D. Calyx-lobes ciliate; leaves pale whitish green. .... *J. rehderianum.*
D. Calyx-lobes eciliate; leaves verdant, not whitish.
E. Calyx-lobes not exceeding 2 mm. in length. *J. cinnamomifolium.*
E. Calyx-lobes much longer, 6–8 mm. long.

* Corolla in *J. robustifolium* unknown.

F. Leaves small, ovate, 4 cm. or less long, ca. 1.5 cm. wide. .... *J. trineuron.*
F. Leaves much longer, 7–10 cm. long, ca. 1.5 cm. wide. .... *J. laurifolium.*
C. Leaves not coriaceous.
D. Flowers red; fruit yellow. .... *J. beesianum.*
D. Flowers white; fruit black. .... *J. nervosum.*
B. Calyx-tube pubescent.
C. Leaves and branchlets flavescent; leaves 2–4 cm. long, chartaceous, appearing nearly triangular. .... *J. nintooides.*
C. Leaves glabrous or pubescent, not flavescent, seldom less than 6 cm. long (occasionally 4–7 cm. in *J. multiflorum*).
D. Inflorescence a 3-flowered cyme subtended by two pairs of bracts with the upper pair considerably longer than the lower; flowers subsessile or nearly so; calyx white or yellowish white in flower. .... *J. albicalyx.*
D. Inflorescence not conspicuously bracteate, even though cymose; calyx green, not white in flower.
E. Corolla conspicuously double, the corolla-tube short, ca. 5 mm. long; leaves with sharply raised primary veins, especially on lower surface. .... *J. sambac.*
E. Corolla simple, with 5 lobes (occasionally 6), the corolla-tube usually 10 mm. or more in length; primary veins usually not conspicuous.
F. Leaves thin, membranaceous; calyx densely pilose with long, whitish pubescence. .... *J. pilosicalyx.*
F. Leaves not particularly thin, some coriaceous; calyx pubescence not long, whitish, pilose.
G. Stem leaves cordate at the base. ...... *J. multiflorum.*
G. Stem leaves cuneate or truncate at the base.
H. Leaves distinctly cuneate at the base. *J. coarctatum.*
H. Leaves truncate or obtuse at the base, not cuneate.
I. Corolla-tube ca. 1 cm. long; leaves elliptic-oblong, 11 × 3.5 cm., very acuminate at the apex, the veins inconspicuous on the upper surface. .... *J. pinfaense.*
I. Corolla-tube up to 3 cm. long; leaves ovate, seldom over 6–7 cm. long, obtuse to broadly acute at the apex, the veins conspicuously depressed on the upper surface. .... *J. amplexicaule.*

FINDING LIST FOR THE TAXA

Accepted names are printed in bold-face type, synonyms in italics.

J. affine Lindl. = **J. officinale**
J. albicalyx Kob.
J. amplexicaule Buch.-Ham.
J. anastomosans Wall. = **J. nervosum**
J. angulare Bunge = **J. nudiflorum**
J. angustifolium Ker. = **J. laurifolium**
J. angustifolium var. *β laurifolium* Ker = **J. laurifolium**
J. anisophyllum Kob.
J. arboreum Ham., not Schultes = **J. diversifolium**
J. argyi Lévl. = **J. floridum**

J. beesianum Forrest & Diels
J. beesianum × *officinale* f. *grandiflorum* = **J. × stephanense**
J. bicorollatum Noronha = **J. sambac**
J. blinii Lévl. = **J. polyanthum**
J. bodinieri Lévl. = **J. sinense**
J. chrysanthemum Roxb. = **J. humile** var. **revolutum**
J. cinnamomifolium Kob.
J. coarctatum Roxb.
J. coffeinum Hand.-Mazz.
J. delafieldii Lévl. = **J. polyanthum**
J. delavayi Franchet = **J. beesianum**
J. discolor Franchet = **J. lanceolarium**
J. dispermum Wall.
J. diversifolium Kob.
J. diversifolium var. **glabricymosum** (W. W. Sm.) Kob.
J. diversifolium var. **subhumile** (W. W. Sm.) Kob.
J. duclouxii (Lévl.) Rehd.
J. dumicola W. W. Sm. = **J. duclouxii**
J. dunnianum Lévl. = **J. lanceolarium** var. **puberulum**
J. esquirolii Lévl. = **J. multiflorum**
J. floridum Bunge
J. floridum var. *spinescens* Diels = **J. floridum**
J. forrestianum Kob.
J. fragrans Salisbury = **J. sambac**
J. fuchsiaefolium Gagn.
J. giraldii Diels
J. grandiflorum L. = **J. officinale** f. **grandiflorum**
J. heterophyllum Roxb. = **J. diversifolium**
J. heterophyllum var. *glabricymosum* W. W. Sm. = **J. diversifolium** var. **glabricymosum**
J. heterophyllum var. *subhumile* W. W. Sm. = **J. diversifolium** var. **subhumile**
J. humile L.
J. humile var. **glabrum** (DC.) Kob.
J. humile var. **siderophyllum** (Lévl.) Kob.
J. inodorum Jacq. = **J. humile**
J. inornatum Hemsley = **J. microcalyx**
J. lanceolarium Roxb.
J. lanceolarium var. **puberulum** Hemsley
J. laurifolium Roxb.
J. macrophyllum Hort. = **J. diversifolium**
J. mairei Lévl. = **J. humile** var. **siderophyllum**
J. mairei var. *siderophyllum* Lévl. = **J. humile** var. **siderophyllum**
J. mesnyi Hance
J. microcalyx Hance
J. multiflorum (Burm. f.) Andrews
J. nervosum Lour.
J. nintooides Rehd.
J. nudiflorum Lindl.
J. nudiflorum f. **aureum** Dippel
J. nudiflorum var. **pulvinatum** (W. W. Sm.) Kob.
J. nudiflorum var. *variegatum* Mouillefert = **J. nudiflorum** f. **aureum**
J. odoratum Noronha = **J. sambac**
J. officinale L.
J. officinale f. **grandiflorum** (L.) Kob.
J. pachyphyllum Hemsley = **J. lanceolarium**
J. paniculatum Roxb. = **J. lanceolarium**
J. pentaneurum Hand.-Mazz.
J. pilosicalyx Kob.
J. pinfaense Gagn.
J. polyanthum Franchet
J. prainii Lévl., syn. nov. = **J. laurifolium** Roxb.
J. primulinum Hemsley = **J. mesnyi**
J. pubescens Willd. = **J. multiflorum**
J. pubigerum D. Don *β glabrum* DC. = **J. humile** var. **glabrum**
J. pulvinatum W. W. Sm. = **J. nudiflorum** var. **pulvinatum**
J. quadrifolium Buch.-Ham. = **J. sambac**
J. quinquinerve Lambert = **J. dispermum**
J. rehderianum Kob.
J. reticulatum Wall. = **J. coarctatum**
J. revolutum Sims = **J. humile** var. **revolutum**
J. robustifolium Kob.
J. sambac (L.) Aiton
J. sambuc Wight = **J. sambac**
J. schneideri Lévl. = **J. duclouxii**
J. seguinii Lévl.
J. shimadae Hayata = **J. lanceolarium**
J. sieboldianum Blume = **J. nudiflorum**
J. sinense Hemsley
J. × stephanense Lemoine & Son

J. subhumile W. W. Sm. = **J. diversifolium var. subhumile**
J. subulatum Lindl. = **J. floridum**
J. taliense W. W. Sm. = **J. seguinii**
J. trineuron Kob.
J. tsinlingense Lingelsheim = **J. giraldii**
J. undulatum Ker-Gawler, not Willd. = **J. amplexicaule**
J. urophyllum Hemsley
J. urophyllum var. *henryi* Rehd. = **J. urophyllum var. wilsonii**
J. urophyllum var. wilsonii Rehd.
J. valbrayi Lévl. = **J. beesianum**
J. viminale Salisbury = **J. officinale**
J. violascens Lingelsheim = **J. beesianum**
J. vulgatum Lamarck = **J. officinale**
J. wallichianum Lindl. = **J. humile** var. **glabrum**
J. wangii Kob.
J. wardii Adamson = **J. beesianum**
J. zambac Roxb. = **J. sambac**
Lonicera cavaleriei Lévl. = **J. sinense**
L. rehderi Lévl. = **J. sinense**
Melodinus duclouxii Lévl. = **J. duclouxii**
Mogorium pubescens Lamarck = **J. multiflorum**
M. sambac Lamarck = **J. sambac**
M. undulatum Lamarck = **J. sambac**
Nyctanthes multiflora Burm. f. = **J. multiflorum**
N. pubescens Retzius = **J. multiflorum**
N. sambac L. = **J. sambac**
N. undulatum L. = **J. sambac**

THE GENERA OF PLUMBAGINACEAE OF THE SOUTHEASTERN UNITED STATES [1]

R. B. Channell and C. E. Wood, Jr.

In a preceding paper in this series (The genera of the Primulales of the southeastern United States, Jour. Arnold Arb. **40**: 268–288. 1959), the Plumbaginaceae were excluded from the order Primulales. However, various authors have associated this family and order (especially through the Primulaceae), on the basis of the pentamerous floral symmetry, sympetalous corolla, obdiplostemony, and unilocular ovary with a single, basal, anatropous ovule. Other authors have treated the Plumbaginaceae as a separate, but related, order, the Plumbaginales. In contrast, Hallier allied the family with the Caryophyllales (Centrospermae), and a recent study by Friedrich (Phyton Austria **6**: 220–263. 1956) led to a similar conclusion. Considering evidence from anatomy, floral morphology, palynology, embryology, and cytology (as well as from ecology and geographical distribution), Friedrich placed the Plumbaginaceae in the Caryophyllales as a separate suborder, Plumbaginineae, perhaps derived from near the Phytolaccaceae (which with Achatocarpaceae, Gyrostemonaceae, Tetragoniaceae, Nyctaginaceae, Molluginaceae, and Ficoidaceae constitute his suborder Phytolaccineae). In such a position the Plumbaginaceae are aberrant in the sympetalous corolla, anatropous ovule and straight embryo. The suggestion of Cronquist (Bull. Jard. Bot. Bruxelles **27**: 22, 23. 1957) that the family be retained in a separate order Plumbaginales, related to but more advanced than the Caryophyllales, seems to be both flexible and reasonable to follow at the present time.

PLUMBAGINACEAE (Leadwort Family)

Perennial [rarely annual] herbs or subshrubs [sometimes lianas] of polygonaceous habit, ours with alternate, simple, entire, exstipulate leaves. Flowers complete, actinomorphic, 5-merous, hypogynous, bracteate, often heterostylous, variously disposed, ours racemose to paniculate or in modified cymes. Calyx synsepalous, plicate, prominently 5–10-ribbed [-angled or -winged], the lobes membranous or scarious, showy, persistent. Corolla sympetalous or of nearly or quite distinct clawed petals, marcescent, the

[1] Prepared for a biologically oriented generic flora of the southeastern United States, a joint project of the Arnold Arboretum and the Gray Herbarium made possible through the support of George R. Cooley and the National Science Foundation. The scheme follows that outlined at the beginning of the series (Jour. Arnold Arb. **39**: 296–346. 1958). Other published portions of these studies will be found in Jour. Arnold Arb. **40**: 94–112, 161–171, 268–288. 1959, and in the present issue. We are indebted to Dr. G. H. M. Lawrence and Dr. L. H. Shinners for their kind help in connection with the nomenclature of *Plumbago capensis*.

lobes contorted and imbricate. Stamens opposite the lobes of the corolla, epipetalous at the base of the corolla or hypogynous, introrse, the anthers 2-loculed, longitudinally dehiscent, the pollen grains often dimorphic. Gynoecium 5-carpellate; styles 1 or 5, linear; stigmas 5, linear [or capitate]; ovary 1, unilocular, usually 5-lobed or -ribbed, the single anatropous, 2-integumented ovule pendulous from a funicle arising from the base of the locule. Fruit an achene, utricle or capsule, wholly or partly enclosed by the persistent calyx. Seed with a straight embryo and firm crystalline-granular endosperm. Embryo sac tetrasporic, 8-nucleate of several distinctive types. (Armeriaceae.)

A family of ten genera and approximately 325 species, chiefly of semi-arid, saline and calcareous situations, of wide geographical distribution, mostly of the Old World, especially the Mediterranean and Central Asiatic regions; a number of species cultivated as ornamentals.

The Plumbaginaceae are distinguished from other sympetalous groups by the combination of obdiplostemony, five styles or style-branches, and unilocular ovary with a solitary basal ovule.

The occurrence over the herbage of two types of epidermal glands which secret mucilage and/or calcium salts is a characteristic feature of the family. Chalk glands are universally present on or depressed below the surface of the leaves and stem, and commonly exude water and calcium salts, the latter finally being dispersed over the surface of the plant by rain. Elevated capitate glands which secrete mucilage occur in various members of the family, but apparently are of more restricted distribution, usually being confined to the leaf-axils and the upper surface of the leaf-bases.

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KEY TO THE GENERA OF PLUMBAGINACEAE

Leaves cauline; flowers short-pedicelled, borne singly at the nodes in spike-like racemes; corolla tubular-salverform, at least twice as long as the calyx; style 1, slender, with 5 stigmas. . . . . 1. *Plumbago.*

Leaves radical; flowers sessile, borne singly or 2 or 3 together in secund spikes, these in panicles or corymbs; corolla of distinct or nearly distinct, long-clawed lobes; styles 5, distinct throughout, filiform, each with a linear-clavate stigma. . . . . 2. *Limonium.*

Tribe PLUMBAGINEAE Spach

1. Plumbago L. Sp. Pl. **1**: 151. 1753; Gen. Pl. ed. 5. 75. 1754.

Leafy herbs or subshrubs of *Polygonum*-like habit, inhabiting hammocks and waste places, the stems somewhat woody and often greatly elongate, the flowers borne in elongate spike-like racemes or panicles at the ends of the branches and in the upper leaf axils. Flowers solitary at the nodes on short pedicels, each subtended by a bract and two lateral bracteoles; at least some species heterostylous. Calyx tubular, truncate at the base, the 5 ribs beset with prominent capitate-glandular trichomes, the somewhat inequilateral triangular lobes short, the sinuses hyaline. Corolla salverform, long-exserted, the lobes broad. Stamens with long, slender filaments free from the corolla; pollen monomorphic, deeply tricolpate with an ornamentation of coarse, blunt spines. Style 1, slender, terminated by a tuft of 5 linear-clavate stigmas; ovary pestle-shaped, the neck tapering into the style. Capsule included, beaked, dehiscent into 5 thick-textured rigid valves, these sometimes coherent at the base and apex; seed linear-oblong, somewhat pointed. Embryo sac of the "Plumbago" type, lacking synergid and antipodal cells. TYPE SPECIES: *P. europaea* L. (The name from Latin, *plumbum*, lead, perhaps alluding to the occurrence of epidermal "chalk" glands, their calcareous exudate imparting a lead-gray color to the herbage.) — LEADWORTS.

A pantropical genus of approximately 20 species, only *Plumbago europaea* and possibly *P. capensis* Thunb. found outside tropical and subtropical regions; one species native in our area, two or more cultivated, one naturalized.

Plumbago scandens L. is an erect, decumbent or climbing, somewhat woody plant, confined in our area to the southern portion of peninsular Florida where it grows in shady hammocks, as well as on shell mounds in open situations. It has a wide distribution through the West Indies to Argentina, Bolivia, and Peru, and also occurs from Texas and Arizona southward through Mexico and Central America. The calyx, 8–9 mm. long at anthesis, bears prominent capitate-glandular trichomes along the ribs from tip to base, but is otherwise glabrous; the tube of the white or purplish corolla is 1.5–2 cm. long.

A second species, an erect, often diffusely branched, cultivated shrub, a native of South Africa, has become naturalized along roadsides and in waste places in some areas of southern Florida. The azure-blue (or white) corollas have tubes 2.5–4 cm. long, and the calyces, 10–12 mm. long at anthesis, are pubescent, in addition to bearing the characteristic gland-tipped trichomes along the distal two-thirds of each rib. Although it has long been known as *Plumbago capensis* Thunb. (1794), the correct name for this plant eventually may prove to be *P. auriculata* Lam. (Encycl. 2: 270. 1786), which was included by Boissier in the synonymy of *P. capensis* in DC. Prodr. 12: 693. 1848. Lamarck's description may apply to this plant, but the critical characters of corolla and calyx, without which certain identification is impossible, are not mentioned. *Plumbago auriculata* was adopted by Merrill (Fl. Manila, 361. 1912) without discussion and apparently only on the basis of Boissier's disposition of the name. He has been followed by several other authors, but it seems best to retain Thunberg's very widely known name unless the holotype of *P. auriculata* can be located and shown to be the plant in question. *Plumbago capensis* is sufficiently hardy to be cultivated on much of the southeastern Coastal Plain, especially near the coast. Chromosome numbers of $2n = 14$ and 16 have been reported for this species. The red-flowered *P. indica* Thunb., a native of southern Asia, is also cultivated in the southeastern United States. Heterostyly has been reported in both of these species.

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Tribe STATICEAE Bartl.

2. **Limonium** Miller, Gard. Dict. Abr. ed. 4. 1754, nom. cons.

Acaulescent herbs of *Rumex*-like habit, with tough, thickened caudices, petioled radical leaves and naked scapes forming ample panicles or corymbs, the ultimate branches bearing the singly disposed flowers or few-flowered spikelets as secund spikes. Flowers sessile or nearly so, subtended by 3 (or more) ensheathing bracts (the inner the longer); [flowers often heterostylous]. Calyx tubular-funnelform, prominently 5-ribbed, the 5 lobes scarious-hyaline in texture, often with smaller intervening lobes or dentate-erose sinuses. Corolla blue or lavender, the 5 lobes nearly or quite distinct, long-clawed. Stamens with long, slender filaments, epipetalous at the base of the corolla claws or nearly hypogynous; pollen tricolpate, monomorphic [or often dimorphic], ornamented with polygonal areoles surrounded by rods with swollen ends arranged in complete rows. Styles 5, rarely 3, separate, linear-filiform, as long as the filaments; stigmas 5, often dimorphic, ours monomorphic, linear-clavate, papillate; ovary short, cuneate-clavate, truncate. Fruit indehiscent, oblong-clavate, prominently 5-angled, truncate, included or exserted from the persistent calyx, usually capped by the marcescent corolla and the 5 style bases. Seed oblong-ovate, the embryo straight, in mealy endosperm. Embryo sac of the "Fritillaria" type. (*Statice* L., 1753, partim, emend. Willd. 1809, nom. rejic.) TYPE SPECIES: *L. vulgare* Mill. (The name derived from *leimonion*, the ancient Greek name, presumably from *leimon*, a marsh.) — SEA-LAVENDER, MARSH-ROSEMARY, CANKER-ROOTS, STATICE.

Approximately 150 species in 16 sections, the genus occurring on all continents; four species in our area, all of sect. LIMONIUM, subsect. LIMONIUM, and in need of re-evaluation.

Limonium angustatum (Gray) Small (not *L. carolinianum* var. *angustatum* sensu Blake), with linear-lanceolate leaves ending in cusps 2 mm. long, is known only from the Florida Keys. *Limonium obtusilobum* Blake, distinguished by the glabrous calyx with obtuse lobes 0.4–0.8 mm. long, is widespread, but apparently uncommon, in Florida. *Limonium carolinianum* (Walt.) Britt. var. *carolinianum*, having quite glabrous calyx tubes with lobes 0.5–0.7 mm. long, is distributed in salt marshes along the coast from

Mississippi to Florida, north to southeastern New Hampshire; var. *compactum* Shinners occurs on the coast of Texas. *Limonium Nashii* Small, characterized by pubescent calyx tubes with lobes 1–1.7 mm. long, occurs from Louisiana to Florida, north to Newfoundland and the Gulf of St. Lawrence. The latter two species apparently intergrade.

Most species of *Limonium* are dimorphic in respect to pollen structure and stigma morphology. Such dimorphic types are self-sterile but cross-compatible. In *L. vulgare* heterostyly of the conventional kind is also known. Monomorphic, self-compatible species with a single pollen- and stigma-type are known in a number of sections. Such monomorphism is regarded by Baker as a secondary development within the genus. The European and South American members of subsect. LIMONIUM are all dimorphic, with one exception, *L. humile* Mill., of Ireland and Britain; all of the North American species, including ours, are monomorphic. Both *L. mexicanum* Blake, of Baja California, and *L. californicum* (Boiss.) Heller, are diploid ($2n = 18$), whereas, on the basis of inferences drawn from pollen measurements, the plants along the Gulf of Mexico and the Atlantic coast are tetraploids.

Balanced chromosome numbers of 12, 14, 16, 18, 28, 36 and 64 ($x = 6, 7, 8, 9$) have been reported for various species of *Limonium*. Plants with somatic numbers of 27, 32, 33, 34, 35 and 37 are either known to be or are suspected of being apomictic, a condition not yet demonstrated in any of the species in subsect. LIMONIUM.

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VANDERBILT UNIVERSITY
AND
THE ARNOLD ARBORETUM

STUDIES ON THE STIPULES OF SIX SPECIES OF VITACEAE

J. J. SHAH

MAJUMDAR (1955, 1956), AND HIS STUDENTS (Mitra and Majumdar, 1952; Majumdar and Pal, 1958) have recently reviewed the work on stipules, and hence no detailed survey of the literature is made here. So far as the writer is aware, the origin and development of stipules of the Vitaceae have not been studied. Even in some of the recent studies on stipules, the earliest stages of stipule initiation and vascularization have not been fully described. Lubbock (1899) described the stipules of the Vine as large and appearing some time before the leaves covering the whole bud. Sinnott and Bailey (1914) reported 3-, 5-, or 7-lacunar nodes in the Vitaceae and stated that the two stipules are broad-based, each opposite a pair of traces. Arshad (1955) studied the nodal anatomy of six species of *Vitis*. Surprisingly, Lawrence (1951) describes the stipules of the Vitaceae as "petiolar."

MATERIALS AND METHODS

The present contribution deals with four species of *Cissus* and two species of *Cayratia*. The species studied are *Cissus quadrangularis* Linn., *C. rotundifolia* Vahl, *C. amazonica* Linden, and a species of *Cissus* which, after an examination of some of the fresh material available on the University campus, I think should probably be considered as a variety of *C. quadrangularis*, together with *Cayratia carnosa* Gagnep. and *C. auriculata* Gamble. The material of *Cissus amazonica* was obtained from the Royal Botanic Gardens, Kew, England. The other materials were collected from the Botanic Garden, M. T. B. College, Surat; the University Botanic Garden, M. S. University, Baroda; and the campus of Annamalai University, Annamalainagar, India. Dr. R. D. Adatia, of Bombay, also kindly supplied some materials, especially of *Cayratia auriculata*. Documenting specimens are in the Herbarium of the M. S. University of Baroda.

Apical buds were fixed in formalin-acetic-alcohol and by usual methods of dehydration and infiltration were embedded in Merck paraffin or Fisher tissuemat. Transverse and longitudinal sections 8–12 μ thick were cut either parallel to or at right angles to the flat surface of the bud. These were stained with safranin and fast green or safranin and anilin blue combinations. Serial hand-cut sections of the mature stem were also examined. The clearing of apical buds and mature nodal portions was done by keeping the materials in 5–10% sodium or potassium hydroxide at room temperature in the oven at 50–60° C. The material was thoroughly washed in water, and, as suggested by Foster (1955), chloral hydrate was also sometimes used. Dilute acetic acid was used to correct too great trans-

parency of the material (Cavers, 1947). The cleared material was then stained with safranin. The material of *Cissus* species gave excellent results. Camera-lucida diagrams were drawn with a Leitz prism-type drawing apparatus.

OBSERVATIONS

General morphology. All the species referred to above are tendril climbers. In all the species of *Cissus* the stipules are prominent, free and lateral. They appear to arise from the stem on either side of the base of the leaf (Figs. 1, 2, 5). In young buds, because of their early development and maturity, the stipules are very conspicuous and fully cover the young primordia of leaves and tendrils (Fig. 2). The stipules, except those of *C. amazonica*, are cordate or ear-shaped, broad and auricled (Figs. 2, 3, 4, 5). Each stipule has at its base two auricular lobes, usually situated below the node and partly covering the internode (Fig. 2).

The stipules of *Cissus amazonica* are large, ovate-falcate, acuminate and hairy (Fig. 9). The stipules of *Cayratia carnosa* are comparatively small, triangular or ovate and hairy (Figs. 6, 7), while those of *Cayratia auriculata* are ear-shaped, as in the three other species of *Cissus*. The basal region of the old stipules of both *Cayratia carnosa* and *Cissus amazonica* sometimes becomes dark and cushion-like. The number of vascular strands present depends upon the age of the stipules (Figs. 3–5, 9A–9C). The vascular strands traverse the stipules almost vertically, and most of them are independent of one another, branching being scarce (Figs. 3–6, 9A–9C). The venation is not always uniform in the stipules of the same species (Figs. 4A, 4B). The stipular scars are cauline.

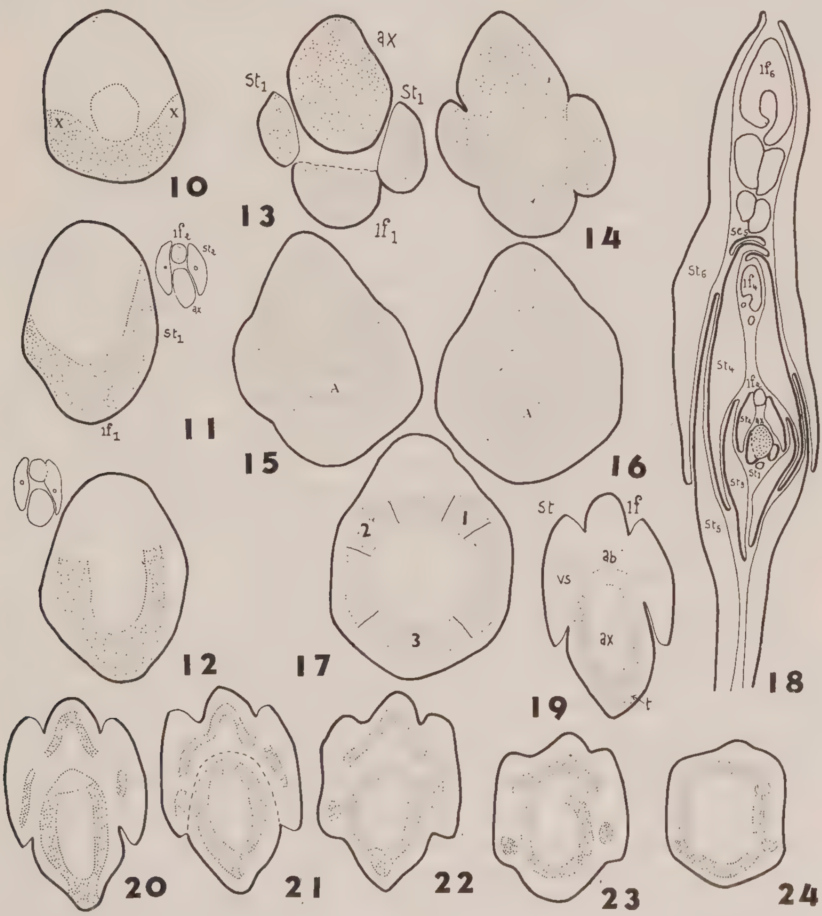
Origin of stipules. The detailed study of the origin of the stipules was concentrated mainly on the *Cissus* sp., *Cissus quadrangularis* and *Cayratia carnosa*, though important stages were ascertained in other species. In *Cissus amazonica* full investigations could not be pursued due to lack of sufficient material. Since most of the stages are similar in the first two species, only the stages observed in the first one will be described fully. Figure 18 illustrates the general arrangement of the stipules and leaves at the shoot apex of the *Cissus* sp. The tangential extensions of the stipule-pairs on either side of the shoot apex and the overlapping of stipular margins on one side only, to form a sort of equitant vernation, are evident. The following table will indicate the relative growth of the leaf and the stipule at the shoot apex. Measurements are in microns.

Node		1	2	3	4	5
Stipule	height	399	848	1441	2288	2627
	width	90	170	210	339	429
Leaf height		174	363	725	1695	5085

FIGS. 1–3, *Cissus* sp.: 1, Habit sketch; 2, Apical tip (numerals indicate the number of primordia from the apex), × 7; 3, Vascular supply of a young leaf and its stipules from a cleared preparation, × 15. FIGS. 4–5, *Cissus quadrangularis*: 4A, B, Two stipules with different venation, × 9; 5, Vascular supply of the leaf and its stipules from a cleared preparation. FIGS. 6–8, *Cayratia carnosa*: 6, 7, Old and young stipules, × 3 and 9, respectively; 8, Hairs of a stipular margin, × 130. FIG. 9, *Cissus amazonica*: A, B, C, Stipules with different venation-patterns, × 2. Abbreviations: ax = axis; lb = basal lobe of the stipule; lf = leaf; lt = lateral leaf trace; mt = median leaf trace; sc = scale of the tendril; st = stipule; t = tendril.

The organization of the shoot apex and the various stages of leaf and tendril development of various species of *Cissus* and *Cayratia* have already been described (Shah, 1956). In *Cissus* and *Cayratia* there are respectively two and three tunica layers. In both genera the initiation of the stipular primordium is first discernible when the shoot apex expands at one of its sectors to form the leaf-buttress (foliar foundation of Majumdar, 1942). The latter is identified as a crescent-shaped area surrounding the rest of the apex (FIGS. 10, 25). Towards its two lateral ends, or flanks, T_2 and

inner corpus cells in *Cissus* divide periclinally and anticlinally forming two small protrusions, the earliest visible stipular primordia. FIGURES 30 and 31 illustrate the comparable histogenic development in *Cayratia*. On the lateral sides of the apex just above the young foliar primordium two regions of stipular initiation (st′) are evident (FIG. 30). In these sections the regions of stipular initiation and the leaf appear to be separated clearly,



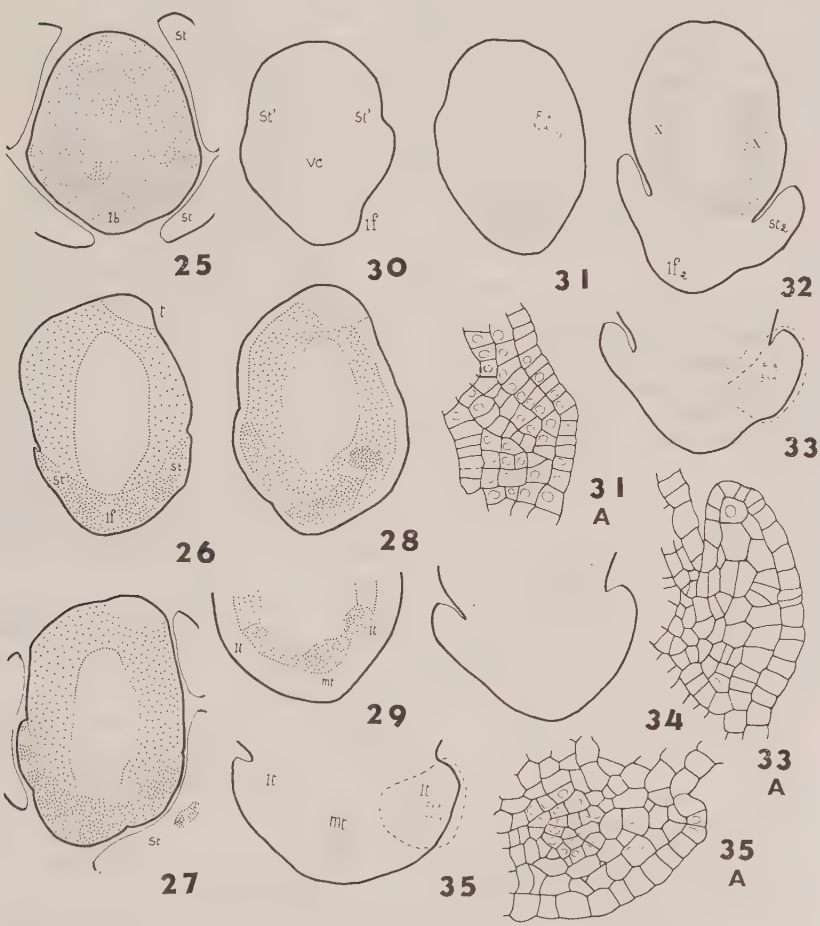
FIGS. 10–18, *Cissus* sp.: 10, Transection of shoot apex at leaf-buttress stage (X = meristematic activity), × 130; 11, 12, Transection of shoot apex at first visible node, 60 and 72 microns below apex, × 130 (inset figs. × 26); 13–17, Serial transections of shoot apex, 40, 50, 70, 90, and 100 microns, respectively, below the apex (height of right and left stipules 30 and 20 microns), A = region that is less stained, × 130; 18, Transection of shoot apex showing general arrangement of stipules and leaves (numerals indicating the respective number of the primordium from the shoot apex), × 22. FIGS. 19–24, *Cissus rotundifolia*: Serial transections of shoot apex at second visible node (Figs. 20–24 respectively from 18, 27, 36, 54 and 81 microns below Fig. 19), all × 70.

though in subsequent stages the stipules appear closely associated with the leaf (FIGS. 26, 27, 32). In fact, the shoot apex at this stage shows three meristematic areas, the two lateral ones belonging to the stipules and the median one to the leaf (FIGS. 26–27, 30–31). At this stage no procambium for the stipule trace could be observed. Cross (1937) reported similar findings in *Morus*, but did not specifically mention that the stipular primordia arose from the leaf buttress. In *Liriodendron* the median portion of the leaf buttress enlarges to become the leaf primordium and its flanks become the stipular primordia (Millington and Gunckel, 1950; Pray, 1955). In *Glycine* (Sun, 1957) the stipular primordia are clearly associated both with the base of the leaf primordium and with the flanks of the shoot apex. However, the stipule is initiated when the leaf primordium is about 70 μ high in *Morus* (Cross, 1937), 60–80 μ high in *Glycine* (Sun, 1957) and in *Opuntia* (Boke, 1944) the stipule is initiated before the leaf is 100 μ long. FIGURES 11 and 12 show an advanced stage in *Cissus*. The right stipule is well developed and its free part is 12 μ high while the left one has no free projection. The two stipules, when observed in conjunction with the apex, show their further horizontal extension almost up to the other side of the apex (FIG. 11), indicating that more apical cells are taking part in the development of the stipule. It can just as well be suggested that the stipule primordia which have originated from the leaf buttress have incorporated into themselves some additional apical tissues. Sussex (1955) also reports that in potato the leaf primordium during its subsequent growth after its initiation encroaches laterally and distally over the apical surface, incorporating into itself the surounding tissues. This obviously means that at least some tissue of the leaf buttress is also used up.

Vascularization. Majumdar (1956, p. 10) while discussing the morphology of the stipules makes the categorical statement that the stipule is "*an outgrowth of the leaf-base caused by the stimulating influence of a branch or branches sent out by the laterals*" of the foliar trace (italics his). However, Majumdar and Pal later (1958) report a case in *Dentella* where the scarious interpetiolar stipules are without any vascular supply. In *Morus*, leaf traces are differentiated after the formation of the stipular primordia (Cross, 1937). Boke (1944) reported no procambium in the young stipule of *Opuntia*. Millington and Gunckel (1950) could not determine with certainty whether or not the procambial traces differentiated prior to formation of the stipular primordia. So far as can be judged from the figures and microphotographs, the stipular primordia of *Glycine* (Sun, 1957) do not show any procambium.

It has been mentioned above that both in *Cissus* and *Cayratia*, the procambium of a stipular trace is not observed at the initiation and subsequent development of the stipule. In FIGURE 11 the right stipule in *Cissus* sp. is 12 μ high, and in FIGURE 12 (12μ below FIG. 11) the residual meristem is recognized by its dense staining and characteristic orientation of cells. The residual meristem at the region of insertion of the leaf primordium is more densely stained. FIGURES 13–17 show an advanced stage.

The stipule primordia are well developed in height and width, the right and left stipules being respectively 30 μ and 20 μ in height. The stipular and foliar primordia in conjunction with the shoot apex appear uniformly stained except the central core region of the apex. About 100 μ below the shoot apex, the vascular meristem is observed as illustrated in FIG. 17. At regions 1, 2 and 3 (FIG. 17) the cells (mostly procambium) appear compactly arranged. Farther below this, four procambium strands, each at one angle and linked with the other by residual meristem are observed. FIGURES 3 and 5 illustrate the nature of the vascular supply of the leaf



FIGS. 25–35, *Cayratia carnosa*: 25, Transection of shoot apex at leaf-buttress (lb, densely stippled) stage, × 130; 26–29, Serial transections of shoot tip at 120, 130, 150 and 170 microns below the apex; 30–35A, Serial transections of shoot tip (Figs. 31–35 from 20, 60, 70, 80, 110 microns respectively below Fig. 30), × 130, except Figs. 31a, 33a, 35a, × 295; vc = vacuolated region; other explanations in the text.

and its stipules. Of the four trace strands (a, b, c, and d in FIG. 5) of the leaf, each of two strands (a and c), subsequently referred to as the girdle traces (Eames and MacDaniels, 1947), makes a semicircular curving or girdling from one side of the axis to the other side where the leaf is inserted. Each unites with the other strand (a with b, c with d, FIG. 5) which is near the leaf base and almost vertically oriented in the axis. All four unite to form the median trace (mt) of the leaf. At a later stage the girdle trace, as it curves to meet the other strand, gives out branches to the stipule. One of the stipular traces, as also the laterals of the leaf, arises from the fused portion of the two vascular strands (FIGS. 3, 5). Since almost all the stipular traces are vertically oriented (FIGS. 4, 6, 9), their origin could be observed accurately in the transverse and surface planes. FIGURE 37 shows the curving of the girdle trace without any stipular trace and FIG. 38 shows how the first stipular trace is differentiated from the girdle trace.

Similar observations are obtained in *Cayratia carnosa* where the node is trilacunar. *Cissus rotundifolia* (FIG. 24) and *Cissus amazonica* have pentalacunar, the *Cissus* species and *Cissus quadrangularis* tetralacunar, and *Cayratia auriculata* 7-lacunar nodes. FIGURES 30–32 show the earliest observed stages of stipule initiation in *Cayratia carnosa.* Regions marked "X" in FIG. 32 show some divisions of residual meristem cells which represent the incipient lateral procambial strands of the foliar primordium. Longitudinal sections also reveal that procambium is absent in the early leaf primordium. Even at a later stage the stipular primordium is without its procambium (FIGS. 26–29). The median trace in FIG. 29 is difficult to distinguish from the adjacent residual meristem cells but the lateral traces are discrete and densely stained. The stipular primordia also arise opposite them. These observations indicate that their initiation is due to the stimulus of the lateral leaf traces. This confirms the view of Sinnott and Bailey (1914) that the lateral traces exert a stimulating influence which results in the formation of the stipule. It does not support Majumdar's recent contention (1956) mentioned above. Arshad (1955) also reports that the origin of stipules in some species of Vitaceae is intimately connected with the branches of the lateral bundles of the leaf trace.

That the differentiation of the stipular trace occurs subsequently to the stipule development is also confirmed by the observation that sometimes only one of the early developed members of the stipular pair shows a procambial strand. FIGURES 32–35 show the vascular relationships of the second stipule from the shoot apex of *Cayratia.* Ten μ above the level of FIG. 33 a group of slightly obliquely cut and procambium-like cells was observed, an indication of the beginning of differentiation of the stipular trace. The lateral leaf traces are very well developed (FIGS. 35, 35A).

FIGURES 39–44 and 45–48 show further development of the vascular system of the stipule and its relation to the foliar girdle trace in *Cissus* and *Cayratia.* The stipule shows two procambial traces (FIG. 39). In the right stipule the traces are obliquely cut as they are about to be united with the girdle trace. In the left one the girdle trace is observed

actually traversing the stipular tissue which is in conjunction with the axial tissue. In *Cayratia* (Figs. 45–48) the free part of the stipule shows only one trace but farther below there are two traces. Figure 47 indicates that the horizontal extensions of the two lateral foliar traces actually traverse the stipular tissue. Figure 35 clearly indicates that the three leaf traces are in the foliar and stipular tissue conjoint with the axis (note the marginal meristem of the stipule in Fig. 35A). The three ridges over the three traces of the axis (Fig. 48) indicate the position of leaf and its

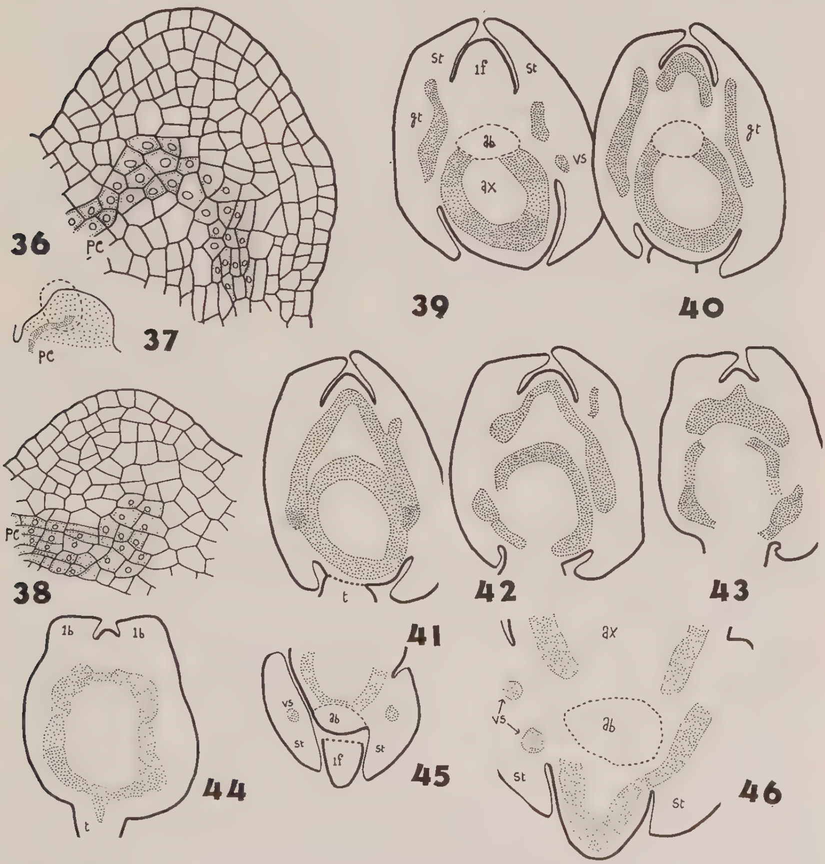


Fig. 36, *Cissus* sp.: Entire stipule with girdle-trace procambium, × 295. Figs. 37, 38, *Cissus rotundifolia*: 37, Entire stipule with differentiation of stipule-trace procambium from the girdle-trace, × 70; 38, Part of Fig. 37 enlarged, × 295. Figs. 39–44, *Cissus* sp.: Serial transections at the third visible node from shoot apex (Figs. 40–44 at 20, 30, 40, 70, and 110 microns respectively below Fig. 39); densely stained vascular meristem closely stippled, × 70. Figs. 45, 46, *Cayratia carnosa*: Serial transections of an older node (Fig. 46 at 30 microns below Fig. 45), × 70, 130, respectively. Abbreviations: ab = axillary bud, ax = axis, gt = girdle trace, lb = stipular lobe, pc = procambium, vs = vertical vascular strands of the stipule.

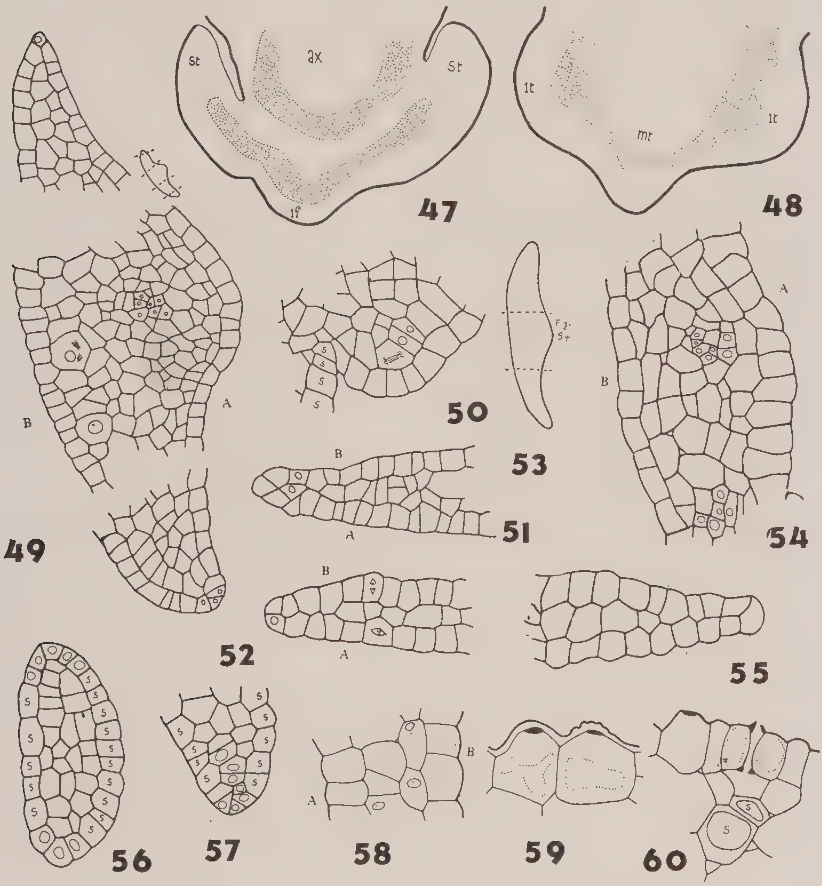
stipules, and FIGURES 19–24 show comparable observations in *Cissus rotundifolia.*

The above observation is an important one, indicating as it does that there is a close morpho-histogenic relationship between the leaf and its stipules. It also confirms the earlier observation that the stipules originate from the flanks of the leaf buttress under the stimulus of the lateral leaf traces. The foliar and stipular tissues confluent with the axis have been derived from the leaf buttress and it is this tissue that the leaf traces traverse after their departure from the axis. The stipular traces arise in that part of the stipule which should be considered as an emergent and free one. Majumdar (1958) in his recent morphological explanation of the stipules of the Rubiaceae explains that the "collar" on which the "free part of the stipule is erected" is a product of union of two or more foliar buttresses at the shoot apex and is confluent with the axis. According to him the division of the leaf trace bundles and all vascular adjustments for the supply of the stipules and the petioles take place in the "collar," while the free limbs of the leaves and their stipules are erected on the "collar" under the influence of their respective trace bundles. As already noted, the present study does not confirm this observation.

Development of the stipule. The general development of the stipule is similar to that of *Morus* (Cross, 1937). The stipule develops rapidly in length and width. The young stipule near its base appears in transverse section to be thickened in the middle, bordered on either side by a pair of thin tangential extensions of meristematic cells (FIGS. 18, 52, 56, 57). Their edges constitute the marginal meristem of which the activity contributes to the lateral growth of the primordium. The marginal growth appears to be rapid on the side distal to the foliage leaf, as a result of which the proximal end of the stipule appears rounded. In *Cayratia* some of the abaxial and adaxial protodermal cells show dark staining contents and the marginal initials and their immediate derivatives appear meristematic (FIGS. 56, 57). The nature of the marginal meristem activity varies. The wedge-shaped marginal initial forms by anticlinal divisions a biseriate wing of adaxial and abaxial layers (FIGS. 52, 55). In FIGURE 52 the submarginal initial is away from the marginal initial and is in line with the abaxial layer (B). The mitotic figure in one of the cells of the abaxial (B) protoderm indicates that this also contributes to the formation of ground meristem. Sometimes the abaxial cell of a biseriate wing (FIG. 51) divides to form an inner cell, isolated from the ground meristem. Cross (1936) and Foster (1937) have reported similar divisions in the bud scales of *Morus* and *Rhododendron.* The activity of the marginal meristem of the two wings may not be uniform. The formation of the auricular lobe of the stipule is observed in the first or second stipule of the *Cissus* species. The frequent divisions in the subprotodermal layers at the base of the stipule produce an auricular prolongation (FIG. 50).

The process of maturation begins in the middle region of the stipule, later extending into lateral wings. The adaxial and abaxial subprotodermal

layers contribute to the central core. Fig. 49 illustrates the first stipule of the *Cissus* species. The stippled cells near the procambium are meristematic. The growth in thickness in the middle region is due to the frequent periclinal divisions in the adaxial subsurface layers. Figs. 53 and 54 show comparable stages of *Cayratia*. The abaxial epidermis has a rapid



Figs. 47, 48, *Cayratia carnosa*: In continuation from Fig. 46, 40 and 120 microns below Fig. 46, × 130. Figs. 49–52, *Cissus* sp.: 49, Transection of young stipule near its base (note single procambium strand, marginally stippled cells near it densely stained, marginal meristem and raphide sac), × 300 (insert × 28); 50, Formation of auricular lobe of the stipule, × 350; 51, 52, Marginal meristem, × 350. Figs. 53–57, *Cayratia carnosa*: 53, Transection of young stipule, × 70; 54, Middle region of Fig. 53, magnified (note two procambium strands), × 295; 55–57, Marginal meristem, × 295; 56, Transection young stipule entire (note marginal meristem), × 295. Figs. 58–60, *Cissus rotundifolia*: 58, Transection of young stipule (completely stippled cells staining blue due to some contents), × 350; 59, 60, Transection of stipule epidermis with stoma, × 350. Abbreviations: A, B = adaxial and abaxial sides; s = deeply stained cells due to some contents.

development and is more thickened in its outer wall (FIGS. 58, 59). It also shows cuticular corrugations which appear tooth-like in transverse section. It is considered to be a sensory epidermis since the epidermis of the tendril also shows similar characteristics. Epidermal corrugations could not be observed in *Cayratia*. FIGURE 60 illustrates a typical stoma in the stipule of *Cissus*. The mesophyll in the mature stipule is not differentiated into palisade and spongy parenchyma. Raphide sacs are present in abundance (FIG. 4) in the mesophyll; the development of these is discernible in very young stipules.

DISCUSSION

The question of the region of origin of the stipules appears to be more or less settled. The present investigation and those of others (Millington and Gunckel, 1950; Pray, 1955; Sun, 1957; Majumdar and Pal, 1958) have proved conclusively that the stipules originate from the flanks of the leaf buttress. The views of Parkin (1948) that the free lateral stipules were cauline and, of Cross (1937) that they originated from leaf-stem transition region (which is a diverged cauline tissue at the node) do not find any support. Sun (1957) also adds that, although stipules of *Glycine* appear to arise directly from the shoot apex, the region of their origin may best be interpreted as an extension of the base of the leaf.

Majumdar (Mitra and Majumdar, 1952; Majumdar, 1955, 1956; Majumdar and Pal, 1958) considers the leaf-buttress as "an integral part of the leaf, and *its real base*" (italics by Majumdar, 1955) on which the foliar and stipular primordia are "erected" under the stimulus of their respective traces. Hence he considers stipules to be leaf-base divergences (not of base of the leaf). Explaining the cause of the origin of stipules, he mentions (1955, 1956) that it is the branch or branches of the lateral leaf traces that form the stipule. The present investigation has shown that the origin of stipules in *Cissus* and *Cayratia* is due to the stimulus of the lateral leaf traces and the subsequent development of the stipule is accompanied by the vascular branches arising from them. This confirms the view of Sinnott and Bailey (1914) that there is some sort of morphogenetic connection between lateral leaf traces and stipules. The broad-based nature of the stipule in the Vitaceae may be explained as due to the girdling of a lateral leaf trace, for the extent of the latter closely parallels the sideward extension of the stipule (see FIG. 5). Arshad (1955) explains the girdling of the lateral leaf trace as due to the incorporation of the leaf-base in the axis.

Whether the leaf-buttress is the real leaf-base and constitutes the axial component of the axis (Mitra and Majumdar, 1952) is a debatable question. Gifford (1954) mentions that "no clear delimitation can be made between the leaf buttress and the upright part of the leaf primordium" and also mentions that the leaf-buttress is not sharply delimited from the shoot apex, an expression of the intrinsic unity of leaf and stem. Majumdar (1955, 1956, 1958) also has not taken into consideration the recent

work on shoot apices by French investigators like Plentofol and Buvat who describe the leaf initiation as the "raising of a localized portion of the 'anneau' by periclinal divisions in superficial layers (except the outer one) as well as in deeper layers" (in Gifford, 1954). The derivation and delimitation of the mantle and the axial core from two different zones of apical meristem (Mitra and Majumdar, 1952) are not supported by recent researches (Wetmore and Wardlaw, 1951; Gifford, 1954; Wardlaw, 1957). The entire apical meristem is interpreted as potentially capable of producing leaf primordia and the phyton concept in the interpretation the shoot has failed to stand the test of experimentation (Wetmore and Wardlaw, 1951). At all stages of development, leaves are appendages borne on an axis (Wetmore and Wardlaw, 1951). Recently Webster and Steeves (1958) reported the occurrence of truly leafless shoots in *Pteridium* and this fact, as they rightly remark, must be kept in mind in formulating any generalizations about leaf-stem relationships. It is conclusively proved, at least in some cases, that the organogenic destiny of a morphological organ such as a leaf is not at all determined at the leaf-buttress stage of its initiation (Wetmore and Wardlaw, 1951; Cutter, 1958). In fact, at this stage it has the alternative potentiality of different morphological expressions. Hence, to accept the interpretation of Majumdar and his students that the leaf-buttress is the real leaf-base and forms the mantle of the axis would be taking for granted those conceptions and features "which stand most in need of investigations by every method at our command" (Wardlaw, 1950).

Also of interest in this discussion are the observations of Boke (1944, 1951, 1952) on the Cactaceae which, according to him, provide one of the best examples substantiating Saunder's leaf-skin theory (1922), which Majumdar and his students (Mitra and Majumdar, 1952; Majumdar and Pal, 1958) support in part. In Cactaceae, according to Boke, there appears to be a progressive development of the leaf-base at the expense of the leaf itself, but no reference to its origin from the leaf-buttress is made. In fact, the existence of the latter is hardly referred to in connection with the initiation of the leaf (Boke, 1951).

Colomb (1887) defined stipules as appendages inserted on the stem at the base of the leaf and from which all the bundles arise exclusively from corresponding foliar bundles. Lubbock (1899) considered them to be normally more or less leaf-like structures at the base of, or just below, and one on each side of the leaf stalk. Sinnott and Bailey (1914) regarded the stipules as morphologically integral portions of the leaf, a generalized concept put forward by Eichler as early as 1861. Millington and Gunckel (1950) interpreted the stipules of *Liriodendron* as the "products of leaf base rather than of stem." Majumdar's concept (1956, 1958) of stipules is already discussed above. On the basis of ontogeny and vascularization the stipules of *Cissus* and *Cayratia* should be considered as the integral parts of the leaf, having their origin from the flanks of the leaf buttress.

I venture to put forward a new concept to explain the presence of stipules. The origin and subsequent development of stipules is closely asso-

ciated with that of leaves having a characteristic nodal structure (Sinnott and Bailey, 1914), i.e., trilacunar or multilacunar. However, the development of the stipule is different from that of the leaf and is similar in many respects to that of the bud scale (Cross, 1937; Sun, 1957). It is well known that the determination of a growth center (see Wardlaw (1957) for the concept of growth center) of the leaf and its early development at the shoot apex are associated with the presence of a single procambial trace; but if the two or more lateral leaf traces differentiate earlier than or simultaneously with the median one, two more lateral growth centers will be established, in addition to the median one for the leaf, at the site of foliar initiation (i.e., the leaf-buttress). Each center has in its initial stages common physiological potentialities of producing an outgrowth of a localized region of the apex. This results in the development of three meristematic regions at the shoot apex. Owing to subsequent changes in the organogenic potentialities between the two lateral and the median regions, the former follow a histogenic development similar in most respects to that of the bud scale to form the stipule, and the median region because of its characteristic histogenic development becomes a leaf primordium (for better appreciation of this concept refer to Cutter's discussion on foliar determination (1958)). How far this explanation will stand the test of experimental research is yet to be seen.

SUMMARY

The origin and development of stipules of six species of the Vitaceae, four of *Cissus* and two of *Cayratia*, have been investigated. The stipules are ear-shaped or triangular, and free lateral. The stipular primordia arise from the flanks of the leaf-buttress. Their initiation is more or less simultaneous with that of the leaf and is closely associated with the lateral leaf traces. The trace procambium in the stipular primordium develops at a later stage. The vertical vascular strands arise from the lateral leaf traces during their girdling round the axis. The subsequent development of the stipule is studied and, in most respects, resembles that of the bud scale. It is concluded that early development of the stipule is due to the stimulus of lateral leaf traces. The origin and morphology of the stipules are discussed with reference to modern researches and a new concept to explain the presence of stipules is put forward.

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ANNAMALAI UNIVERSITY
ANNAMALAINAGAR, INDIA

THE GENERA OF THEACEAE OF THE SOUTHEASTERN UNITED STATES [1]

CARROLL E. WOOD, JR.

THEACEAE (CAMELLIA FAMILY)

Shrubs or trees with simple, alternate, exstipulate leaves. Flowers complete, showy, borne singly in the axils of the leaves. Sepals 5(6), imbricate (quincuncial: 2 outside, 2 inside, 1 in-and-out), the calyx with 1–4 often caducous bracteoles. Petals 5(6–8), white, imbricate, the outermost usually smallest and somewhat cupped, united at the base. Stamens numerous, adnate to the petals. Gynoecium of 5 partly or wholly united carpels, the ovary superior, the locules 5; ovules 4–10 per locule, the placentation axile. Fruit a dehiscent capsule. (Ternstroemiaceae.) TYPE GENUS: *Thea* L. = *Camellia* L.

About 500 species in some 30 genera, primarily in the tropics of both hemispheres. Represented with us by four distinct species in three genera of the tribe CAMELIEAE DC. Generic and specific distinctions are often difficult in the family and the number of species and genera may be considerably fewer than indicated. The family as a whole is characterized by an abundance of sclereids, often of considerable size, in nearly all organs. Anatomical features have been used in conjunction with morphological characteristics in the separation and alignment of genera, but in most instances far too few representatives have been examined to warrant the weight sometimes given this evidence. Representatives of the exotic genera *Camellia* (including *Thea*), *Eurya* Thunb., *Cleyera* Thunb., and *Ternstroemia* L. f. are in cultivation in our area. Except for *Camellia* ($2n$ = 30, 45, 60, 90), little is known of chromosomes, embryology, or genetics. The family is notable for extreme endemism, on the one hand, and polymorphic, often ill-defined species, on the other.

[1] Prepared for a biologically oriented generic flora of the southeastern United States, a joint project of the Arnold Arboretum and the Gray Herbarium made possible through the support of George R. Cooley and the National Science Foundation. The scheme follows that outlined at the beginning of the series (Jour. Arnold Arb. **39**: 296–346. 1958). Other published portions of these studies will be found in Jour. Arnold Arb. **40**: 94–112, 161–171, 268–288. 1959, and in the present issue. In connection with this family, I am especially grateful to Dr. C. E. Kobuski for his kind and generous advice. Fresh specimens used in illustrating the fruit of *Franklinia* and *Gordonia* were provided through the kindness of Mrs. J. Norman Henry from plants cultivated at the Henry Foundation, Gladwyne, Pennsylvania; flowering specimens of *Gordonia* were collected by Dr. R. B. Channell and Dr. H. F. L. Rock, in Bladen County, N. C.

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KEY TO THE GENERA OF THEACEAE

A. Seeds with a pronounced oblong wing at the upper end; capsule ovoid, loculicidally dehiscent, with a persistent central axis; sepals suborbicular, persistent at least into young fruit; foliage coriaceous, evergreen; bases of stamen-filaments united to form conspicuous fleshy pads. . . . . . . 1. *Gordonia*.

A. Seeds wingless or with only a narrow membranaceous margin; foliage membranaceous, deciduous; bases of filaments not united to form conspicuous pads.

  B. Capsule globose, dehiscing loculicidally from above and septicidally from below, with a persistent central axis; sepals suborbicular, dehiscent at or soon after anthesis; capsule maturing a year after flowering. 2. *Franklinia*.

  B. Capsule dehiscing loculicidally from above only, a central axis absent; sepals ovate to oblong-ovate, persistent into fruit; capsule maturing within a single season. . . . . 3. *Stewartia*.

1. **Gordonia** Ellis, Roy. Soc. London Phil. Trans. **60**: 520. *pl. 11.* 1771, nom. cons.

Shrub or tree to about 25 m. tall and 50(–65) cm. in diameter, with persistent, glabrous, lanceolate to oblong-lanceolate to elliptic leaves. Flow-

ers long-peduncled, with 4 bracteoles below the calyx deciduous before anthesis. Sepals 5, deciduous in late fruit. Both sepals and petals silky-pubescent on the outer surface. Stamens in 5 groups coherent at the bases to form 5 thick, fleshy pads adnate to the base of the corolla and coherent with each other to form a deeply 5-lobed ring. Ovary ovoid, pubescent, gradually contracted into a stout, persistent style, 5-loculed, the ovules 4–8 in each locule, the style elongate, erect, the stigma 5-lobed. Capsule subligneous, ovoid, acute at the apex, 1.5–2 cm. long, dehiscing loculicidally, with a persistent, angled central axis. Seeds compressed, the woody testa prolonged upwards into an oblong wing. (*Lasianthus* Adans. 1763, nom. rejic.) TYPE SPECIES: *G. Lasianthus* (L.) Ellis. (The name in honor of James Gordon, 1728–1791, a nurseryman at Mile-End, near London, "to whom the science of botany is highly indebted, and whose merit is universally known for his great knowledge in the cultivation of exotic plants.") — LOBLOLLY BAY, BAY, BLACK LAUREL, HOLLY BAY, SWAMP LAUREL, TAN BAY.

Primarily a genus of tropical and subtropical Asia, with about 30 species, all evergreen. Represented with us only by *G. Lasianthus*, a well marked species which occurs on the Coastal Plain from eastern North Carolina, south to the region of Lake Okeechobee, Florida, and west along the Gulf of Mexico to Mississippi, always in acid, peaty soils of nonalluvial branch- and creek-swamps, pocosins, hammocks, bays, sand-hill bogs, etc. Flowering from July and August, the plant is a handsome tree, sometimes cultivated. It is hardy as far north as Philadelphia. The bark and wood are rich in tannin; the wood is close-grained and easily worked but is not very durable. In late summer the younger leaves are almost characteristically insect-chewed.

The Asiatic species of the genus, with bracteoles varying from two to many and with a gradual transition of sepals into petals, are sometimes segregated as *Polyspora* Sweet ex G. Don. The Old and New World plants seem to differ in various anatomical aspects, but very few of the Old World species have been studied. Our species clearly seems to be closely related to the Old World Gordonias and to represent a survivor of once more widely dispersed types. Fossil Gordonias are reported from Europe and the western United States.

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2. **Franklinia** Marshall, Arbustrum Americanum 48. 1785.

Shrub or tree to about 10 m. tall, with membranaceous, deciduous

FIG. 1. THEACEAE. a–g. **Franklinia.** *F. Alatamaha*: a, fruiting branch prior to flowering, bearing fruit of two preceding years — note sympodial growth, $\times \frac{1}{6}$; b, bud showing outermost sepal and two bracteoles, $\times \frac{2}{3}$; c, flower, $\times \frac{1}{3}$; d, petal with group of stamens attached, $\times \frac{2}{3}$; e, pistil, $\times 1$; f, old fruit from which seeds have been shed, $\times 1$; g, seed, $\times 2$. h–m. **Gordonia.** *G. Lasianthus:* h, tip of flowering branch, $\times \frac{1}{3}$; i, bud with four bracteoles, $\times \frac{2}{3}$; j, petal with stamens attached — note fleshy pad composed of united bases of stamens, $\times \frac{2}{3}$; k, calyx and pistil, the outermost sepal removed, $\times 1$; l, fruit from which seeds have been shed, $\times 1$; m, seed, $\times 2$. n–q. **Stewartia.** *S. ovata*: n, flowering branchlet of f. *grandiflora*, $\times \frac{1}{3}$; o, flower of f. *ovata*, $\times \frac{1}{3}$; p, loculicidal capsule, partly opened, with persistent calyx, $\times 1$; q, seed, $\times 2$. (Drawn by Dorothy H. Marsh.)

oblong-lanceolate to oblanceolate leaves, tapering to the base. Flowers in the axils of crowded upper leaves, the buds with 2 quickly deciduous bracteoles below the calyx. Sepals 5, suborbicular, imbricate, coriaceous, deciduous at or soon after anthesis. Petals 5, up to 6 cm. long. Stamens in 5 distinct groups, the filaments free, adnate to the base of the corolla. Ovary rounded, truncate at the apex, densely pubescent, the sides conspicuously ridged by the pressure of stamen filaments, 5-loculed; style elongate, deciduous, the stigma 5-lobed. Capsule subglobose, woody, with a persistent central axis, dehiscing loculicidally from above to the middle, septicidally from below to the middle. Seeds 6–10 in each locule, closely packed in two rows, angular, the shape varying with the position within the locule, wingless. (*Lacathea* Salisb.) TYPE SPECIES: *F. Alatamaha* Marshall. (Named for Benjamin Franklin, American philosopher and statesman, 1706–1790.) — FRANKLINIA, FRANKLIN-TREE, LOST CAMELLIA.

A single species, *F. Alatamaha*, now known only in cultivation and formerly known only from an area of two or three acres of "sand-hill bog" or "branch-swamp" at the edge of sand hills about two miles from Fort Barrington, on the Altamaha (Alatamaha) River, in McIntosh County, Georgia, where it was first seen by John Bartram and his son, William, on October 1, 1765. The species was last seen at this spot by Moses Marshall, a nephew of Humphry Marshall, in 1790. It has not been found again in the wild in spite of repeated searches dating from about 1881. *Franklinia* has been cultivated in England since about 1774, however, and it is known that in 1777 William Bartram collected at Fort Barrington ripe seeds from which were grown plants which flowered in four years at Philadelphia. Most of the plants now in cultivation in the United States are thought to be descendants of a plant rescued by the Meehans of Philadelphia from Bartram's then-neglected garden some years before it was taken over by the city of Philadelphia. Attempts on the part of Humphry and Moses Marshall to fill large orders for *Franklinia* plants placed by a London firm in 1787 and 1789 may well have played a fatal part in the extinction of the colony at Fort Barrington.

The probable associates of *Franklinia* at the type locality include *Pinckneya, Pinus serotina* Michx. f., *Magnolia virginiana* L., *Cliftonia*, *Persea*, *Liriodendron*, *Lyonia lucida* (Lam.) K. Koch, *Smilax laurifolia* L., and *Sphagnum*, with *Rhododendron* (*Azalea*), *Leucothoë*, *Serenoa*, *Kalmia hirsuta* Walt., and *Styrax americana* L. var. *pulverulenta* (Michx.) Rehd. between bog and sand hill. (See Harper and Leeds.) The plant should be looked for carefully in similar areas both up and down river from Fort Barrington and in the neighboring Altamaha Grit region. It is not a plant of river-swamps but of acid, nonalluvial bogs at the heads of sand-hill branches (about 20 feet above sea level at the Fort Barrington locality).

As a cultivated plant the handsome flowers are usually produced from July (or, in the North, from late August or September) until frost. According to Bartram, however, at Fort Barrington the plant flowered from "April untill the autumn when it ceases flowering, whilst the seed of the flowers

of the preceding year are ripening," and at Thomasville, Georgia, it is reported to flower in April and May. Wherry suggests that the plant is nearly self-sterile and that seeds from self-pollinated plants do not germinate. Seedlings have been grown from plants in cultivation, however, and this matter needs to be checked. In spite of its extreme endemism on the coastal plain of Georgia, the plant is hardy as far north as Boston, flourishing in acid soils which are a prerequisite to its cultivation.

Although known for many years as *Gordonia pubescens*, and later as *Gordonia "altamaha," Franklinia* is distinct from all members of *Gordonia* in fruit shape and unique dehiscence, wingless seeds, and membranous and deciduous leaves. It differs further from *G. Lasianthus* in the deciduous calyx with two (instead of four) bracteoles, the sessile flowers, the free filaments, and the full year necessary for the maturation of the fruit.

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3. **Stewartia** L. Sp. Pl. 2: 698. 1753; Gen. Pl. ed. 5. 311. 1754.

Shrubs or small trees with membranaceous, serrulate leaves. Flowers with 1 or 2 bracteoles below the calyx. Sepals 5(6), somewhat unequal, persistent. Petals 5(6–8), obovate to rounded, crenulate, silky pubescent on the outer surface. Stamens numerous, the filaments united at their bases to form a shallow ring adnate to the base of the corolla. Styles 5, distinct, or united and stigmas 5. Capsule globose to ovoid, loculicidally dehiscent, lacking a central columella, woody, pubescent. Seeds compressed, 1–4, attached near the base of each locule, obovate-lenticular, the testa thick and crustaceous, with or without a thinner margin. (*Stuartia* L'Hér.; including *Malachodendron* Cav.) TYPE SPECIES: *S. Malacodendron* L. (The name in honor of John Stuart, 1713–1791, third Earl of Bute, who was distinguished in his day as a botanist.) — STEWARTIA.

A genus of about six species of eastern Asia and the southeastern United States, represented with us by two very distinct species. *Stewartia ovata* (Cav.) Weatherby (*S. pentagyna* L'Hér.), with five styles and dull, reddish-brown seeds with a narrow, thin margin, is primarily a plant of the

southern Appalachians in southeastern Kentucky, eastern Tennessee, western North Carolina, northern Georgia, and to central Alabama. *Stewartia Malacodendron* L., with united styles and lustrous, angled seeds lacking an evident margin, ranges more widely, primarily on the Coastal Plain and in the Piedmont (with but a few mountain stations) from Virginia to Louisiana, and with a station in Ouachita County, Arkansas. Both species, although very distinct, are obviously closely related to each other and to the Asiatic species, so much so that the genus *Malachodendron* (*S. ovata*) can be regarded only as a purely artificial segregate. Like *S. Malacodendron*, all of the Asiatic species have united styles.

Both are showy plants, worthy of more widespread cultivation. *Stewartia Malacodendron* flowered in Catesby's garden in England in 1742, and *S. ovata* has been cultivated since about 1785. The latter is the hardier plant, withstanding the winters of eastern Massachusetts. An acid soil is necessary. Propagation is by seeds or softwood cuttings. *Stewartia ovata* f. *grandiflora* (Bean) Kobuski [2] is a handsome plant, often with more than five petals and with purple, instead of white, stamen-filaments. It occurs with the white-filamented form, f. *ovata*, in some localities. The filaments of *S. Malacodendron* are purple.

Anatomically, the genus is interesting in that those species thus far examined lack sclereids (except in the pedicels), in contrast to other members of the family.

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[2] **Stewartia ovata** (Cav.) Weatherby, forma **grandiflora** (Bean) Kobuski, **comb. nov.** *S. pentagyna* L'Hér. var. *grandiflora* Bean, Trees & Shrubs Brit. Isles 2: 555. 1914. *S. ovata* var. *grandiflora* (Bean) Weatherby, Rhodora **41**: 198. 1939. *Malachodendron pentagynum grandiflorum* E. J. Alexander, Addisonia **19:** 1. *pl. 609*. 1935. Since the form of *Stewartia ovata* with purple filaments is well known in horticulture, it seems worth while to have a nomenclatural combination more nearly indicative of its taxonomic status which, it now appears, is not that of a geographical varietas. Both this and the typical form may occur together, and there appears to be no geographical segregation. In addition, one plant in the living collections of the Arnold Arboretum (No. 18244-B, from T. G. Harbison, Highlands, N. C., in 1925) behaves in much the same way as some of the mutable forms of *Camellia japonica*, producing 5-petaled flowers with either purple or nearly white filaments, or occasionally chimeric flowers with both. Another, more vigorous plant (18244-A) of the same collection produces only flowers with purple filaments and with 5–7 petals. (See *Fig. 1, n*, drawn from the latter plant.) — C. E. KOBUSKI.

THE DIRECTOR'S REPORT

The Arnold Arboretum During the Fiscal Year Ended June 30, 1959

THE PAST YEAR has been a particularly satisfying one for the director and the staff of the Arnold Arboretum. Four years have been devoted to combining the non-horticultural herbarium collections of the Arnold Arboretum with those of the Gray Herbarium in the Harvard University Herbarium Building in Cambridge. The task was finished in May of 1959. Work continues on a reorganization of the horticultural herbarium in the Administration Building in Jamaica Plain. Both collections now are in excellent condition, well housed physically and arranged in the most convenient way for the horticultural, monographic and floristic work of the staff. The staff has justifiable pride in a job well done.

To parallel this accomplishment, the grounds and the plantings of the Arnold Arboretum in Jamaica Plain and Weston are in superb condition and the spring bloom of the spectacular trees and shrubs has rarely been equalled. The Boston Department of Parks and Recreation completed the cleaning of the cobblestone gutters and plans a rehabilitation of the roads and benches. Rarely has the Arnold Arboretum, in all its aspects, been in such excellent shape.

The Staff:

Mr. John Thomas Park retired on May 31 as superintendent of the Case Estates of the Arnold Arboretum in Weston, Mass. Mr. Park had spent nearly all of his life on the Case Estates. He worked for Miss Marion Roby Case as a boy and was superintendent of the property when the estate was bequeathed to Harvard University for the Arnold Arboretum in 1945. It is obvious that a lifetime devoted to gardening and horticulture in New England will not end with his retirement and "Tom" will be available for consulting with the staff.

During the spring semester of 1959 Dr. Karl Sax, cytogeneticist for the Arnold Arboretum, was granted a sabbatical leave of absence to accept an appointment as Visiting Professor of Forestry at the University of Florida. Dr. Sax reached the age of sixty-five on November 2, 1957, and will retire on August 30, 1959, just two months after the start of the next fiscal year. His appointment as Visiting Professor of Botany at Yale University for the next academic year has been announced. Dr. Sax has also been awarded a Guggenheim Fellowship for continuing his research in Oxford, England, following the completion of his year at Yale. The Guggenheim appointment was announced in May, 1959. It is with pride we note that Dr. Sax was elected president of the Genetics Society of America for 1959 at the annual meeting of the Society held in Montreal.

Dr. Donald Wyman served for the fifth year as chairman of the "Norman Jay Colman Jury of Award" of the American Association of Nurserymen. He continues to serve as secretary and as treasurer of the American Horticultural Council.

Dr. Burdette Lewis Wagenknecht was appointed horticultural taxonomist at the Arnold Arboretum July 1, 1958. Dr. Wagenknecht received his early botanical training at the University of Iowa and his Ph.D. degree at the University of Kansas. Dr. Wagenknecht will be responsible for the horticultural herbarium under the direction of the curator and will assist in horticultural identification and carry on studies of cultivated woody taxa at Jamaica Plain.

It is a pleasure to note the award of a "large gold medal" to Mrs. Susan B. McKelvey by the Massachusetts Horticultural Society in recognition of her outstanding horticultural writings.

Horticulture:

The past winter was unusually hard on broad-leaved evergreens throughout the entire northeastern United States. At the Arnold Arboretum in Jamaica Plain, and especially at the Case Estates in Weston, the extreme

An aerial view of the Arnold Arboretum (delimited by the white line) looking approximately northeast from a point over Roslindale. Peters Hill is the grassy area in the foreground. Jamaica Pond shows in the left center, with downtown Boston in the background. (Photograph made August 20, 1958.)

foliage burn and actual death of many plants seemed particularly severe. The mountain laurel (*Kalmia latifolia*) and the several varieties of *Ilex crenata* suffered severe branch damage. At Weston, young plants of evergreen *Rhododendron* varieties were killed in large numbers and even established plants twenty years old were killed to the ground. Surprisingly, the *Buxus* collection was largely untouched by the winter weather, and there was little killing of deciduous plants or their flower buds. The damage appears to have been caused, first by an early and sudden freeze which eventually reached a depth of nearly four feet, and then by the many sunny and windy days without a snow cover. The plants did not show bark cracks or the usual signs of stem- and leaf-freeze but appeared to be in good condition until the first warm weather of spring revealed complete desiccation of the branch-systems. The spring months have produced very irregular leafing-out, and, in many cases, severe pruning will be required to re-shape the surviving plants. Much information can be obtained from a study of the cold-desiccation damage of the past winter.

The spring flowering season was one of the most beautiful of the past decade. The cherries, crab apples, forsythias and azaleas were especially outstanding. The magnolias, lilacs and flowering quinces were below average in quality and quantity of bloom.

During the two planting periods, the fall of 1958 and the spring of 1959, 257 different taxa were added to the Arboretum collections. These included plants completely new to our collection, additional clones for trial and replacements of taxa which have been lost. Small rhododendrons were added to the expanding collection on the steep slopes of Hemlock Hill, and the majority of these survived the winter without damage. Only a few were actually lost. The entrance to the Peter's Hill tract was graded properly and planted to extend the crab apple collection so that it can be seen from Bussey Street. A special planting of tree peonies (*Paeonia suffruticosa*) was established on the grounds, and fifty of the cultivars most promising for both hardiness and beauty were planted. The large collection of azaleas on Bussey Hill was pruned for rejuvenation. A cleaning program was continued on the top of Hemlock Hill where recent hurricanes and summer droughts have affected many of the older hemlock trees.

Modern spray equipment has enabled the grounds staff to maintain the plantings in particularly healthy condition. During the past year, time was available to study controls of specific pests of such genera as *Viburnum*, *Robinia* and *Sorbus* which are vulnerable to borer attacks. Due to the constant attention the plants receive, no new outbreaks of disease were found.

The staff particularly appreciates the co-operation received from the Department of Parks and Recreation of the City of Boston in some major repairs completed during the year. The cobblestone gutters are a mark of distinction on the Arboretum grounds. During the past three years sections of these gutters have been cleaned and repaired, and the work has now been completed throughout the grounds. Routine cleaning and the application of weed killers to discourage weed growth will prevent a repetition of the

overgrown and unsightly appearance that existed five years ago. In addition, the stream near the administration building was straightened and deepened to prevent flooding. Flooding and erosion were also threatening the collections of *Pseudolarix* and *Larix* and one section of the stream bank in this area was lined with heavy stones. Excellent co-operation has been received from the Boston Police Department in policing the grounds.

Dr. Donald Wyman continued to serve as co-ordinator for a committee representing the arboreta of the U.S. working in co-operation with the U.S. Department of Agriculture in introducing plants, the importation of which is prohibited at present. This spring 380 taxa were requested from foreign sources for eventual introduction into cultivation in America. Eleven taxa of cultivated plants were released from quarantine this spring and planted in the Arboretum. As part of our program to make little known plants available to commercial nurseries through a co-operating nursery program, eleven taxa of woody plants were offered. Plants were requested by 57 commercial nurseries which will propagate and advertise these unusual plants worthy of more extensive cultivation.

A series of special projects involving the horticultural herbarium and the living collections was inaugurated during the year. The Arnold Arboretum maintains one of the most extensive files of photographic negatives and prints of cultivated plants. Many of the introductions to our collections during the past five years have now reached the size where they flower heavily and can be considered typical in form. These plants are being photographed in color and in black and white for teaching purposes and for the illustration of staff papers. Herbarium specimens are being made of all plants introduced since 1949 when such work was stopped. These plants are being checked for correctness of name, and specimens are being filed for study in the horticultural herbarium. The Arnold Arboretum maintains the most completely and accurately identified living collection and the staff makes a continuous effort to keep it in this condition.

The propagation department under the direction of Mr. Alfred Fordham remains one of the busiest departments of the Arnold Arboretum. While visitors will continue to receive all aid possible for their individual problems it is obvious that some co-ordination of visitors to the greenhouse must be established. During the year nearly 100 classes and groups were taken on conducted tours through the propagation department. Numerous requests for aid in problems of plant propagation, insect control, and general horticultural practice are received by phone or personal visit and handled as possible.

During the year 223 shipments of seeds and plant materials comprising 611 taxa were received from the United States and 14 foreign countries. In response to requests 341 shipments of living plants, propagating materials, seeds, pollen or cytological material were made to other gardens or scientists in the United States and in foreign countries.

Experimental work in plant propagation continues in the greenhouses. Many of the plants in our living collections have never been adequately studied and complete records of propagation and of seed germination are

The Arnold Arboretum in late May, 1959. ABOVE: The Meadow Road near the shrub collection. BELOW: The road past the lilac collection to Bussey Hill.

being compiled from existing literature or from experiments. The routine work in propagation offers many opportunities for experimental variations in normal procedures. The use of different concentrations and types of root-inducing hormones in conjunction with different collecting techniques are examples of experimental projects of value. During the past year it has been determined that application of rooting hormones in the field as the propagating material is cut produces higher rooting percentages than if the application is delayed only a few hours until the worker returns to the greenhouse. *Rhododendron smirnowii* treated in the field at the time of collection rooted 100% while a control collection handled in the normal fashion and treated only hours later in the greenhouse rooted 66% with root systems inferior to the field-treated material.

Experimental work with cuttings of a larger diameter than usual have produced promising results, particularly in *Cedrus libani*, a plant normally difficult to root. Cuttings over one-fourth inch in diameter rooted well in a controlled experiment. This project is being continued.

The International Code of Nomenclature for Cultivated Plants published in 1958 proposes the registration of cultivar names for new horticultural plants. This principle has been accepted by horticulturists at the international as well as national level. Societies in some countries have accepted the responsibility for many specific groups of cultivated plants, such as *Tulipa*, *Iris*, *Rosa*, *Hemerocallis*, *Narcissus*, *Rhododendron*, *Populus* and others. The vast majority of woody plants which are the interest of the Arnold Arboretum, however, is not represented by societies willing to serve as registration authorities. The Arnold Arboretum has volunteered to accept the registration responsibility for woody groups not represented by societies. At a preliminary meeting of representatives of the American Association of Nurserymen, the American Association of Botanical Gardens and Arboretums and the American Horticultural Council it was voted that the responsibility for the over-all program of registering woody plants should be undertaken by the AABGA at the request of the American Horticultural Council. If approved by the membership of the respective organizations, the American Association of Botanic Gardens and Arboretums would then designate the Arnold Arboretum as the National Registration Center for Woody Plants. It was understood that an attempt would be made to find other organizations willing to assist in this large task as their location or staff interest permitted. Registration activity would be in accordance with the directives of the International Code of Nomenclature for Cultivated Plants. However, the Arnold Arboretum reserved the right to require and hold as part of its activity an adequate description, illustration, type herbarium specimen and a living specimen. A small charge would be made to individuals or companies wishing to register a cultivar name. The Arboretum agreed to compile and publish as soon as possible lists of cultivars in groups of registration interest. While the initial agreement when ratified will be for a two year trial period, it is fully expected that the registration, classification, publication and study of cultivated plants will be a major project continuing at the Arnold Arboretum where living

collections, herbarium specimens, library, nursery catalogues and the Rehder Index combine to make this work practicable.

Case Estates:

The more rigorous climate of the Case Estates as a nursery and testing area for the Arnold Arboretum was clearly demonstrated during the past winter. Young plants from the greenhouse in Jamaica Plain are normally transferred to Weston where more adequate space is available for young plants to develop. The Weston environment is more open than that of Jamaica Plain and temperatures may average 12 degrees colder. The severe winter produced a much higher proportion of kill in comparable nursery plants in Weston than in Jamaica Plain. Dead or severely damaged plants were evident in all but the most protected areas on the Case Estates. Considerable replanting of the ground-cover collection was necessary and the time and labor required to renovate the collections prevented the scheduling of an Open House in the first weeks of May as has been our custom.

An area of the Case Estates was taken by the town of Weston for new schools, as was mentioned in last year's report. Construction of the new school began in the fall, and during the winter it was found necessary to clear new fire lanes to protect the rear boundaries of our wooded areas. We expect to construct several new access roads for fire protection during the next year. Since these back areas will also be visible to the public from a new direction, considerable labor has been devoted to clearing and cleaning out brush from the wooded areas.

The Department of Buildings and Grounds was offered surplus trees and shrubs for planting on the Harvard campus and in conjunction with the building program for Harvard College. This is in accordance with the terms of the Arboretum trust. About 350 plants of 130 species and varieties were selected for planting in the Cambridge area.

Education:

The popular classes in horticulture and botany offered by staff members continued during the year with over 230 people registered. The largest classes again proved to be those conducted by Dr. Wyman in Jamaica Plain and Dr. Howard at the Case Estates. New classes offered included advanced plant propagation, classification of the lower plants, and preparation of botanical specimens. The demand for advanced work in the field of plant propagation was met in part by an advanced class offered by Mr. Alfred Fordham. The class met in 12 sessions at irregular intervals during the year when appropriate propagating techniques could be effectively used. Mr. G. Safford Torrey, professor emeritus of the University of Connecticut, was invited to offer a class in the classification of the mosses, fungi, lichens and algae. This class met on the Case Estates in Weston and proved to be extremely rewarding. Each student made a collection of these often-neglected lower plants, and an extra set of specimens was prepared to be presented to the biology class of Weston High School. Sufficient rain during

ABOVE: Professor G. S. Torrey points out lichens on a rotted stump to a group of students at the Case Estates.

BELOW: Seven busses await participants in the annual Field Day of the Massachusetts Horticultural Society held at Jamaica Plain and conducted by staff members of the Arnold Arboretum.

the month of May kept this flora in excellent condition for the course. Dr. Wagenknecht offered an evening class at Jamaica Plain for students interested in classification of flowering plants and the preparation of specimens for class-room or personal collections. Students brought sufficient material for the preparation of duplicate specimens of cultivated plants to be added to the horticultural herbarium.

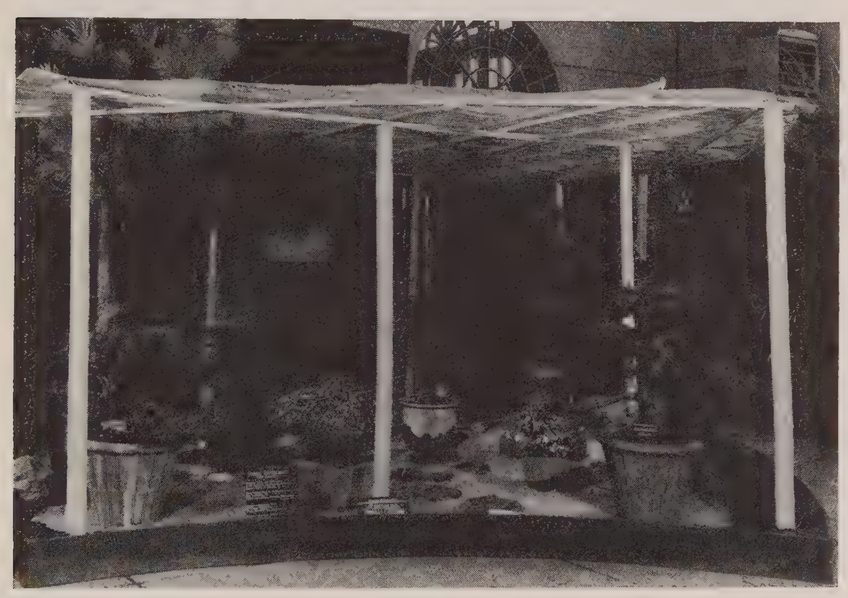
Approximately fifty special tours were conducted on the Arboretum grounds for groups requesting such trips. The largest tour again this year was the Massachusetts Horticultural Society Field Day, held on May 23, the peak of lilac bloom. Approximately 500 people were conducted around the grounds in chartered busses.

Staff members represented the Arboretum at scientific meetings or presented lectures for various groups interested in horticulture. Dr. Sax and Dr. Howard were again appointed lecturers for the visiting lecturer program sponsored by the American Institute of Biological Sciences. Under these auspices Dr. Sax lectured on the Fort Valley College campus, in Fort Valley, Georgia, and Dr. Howard visited the Franklin and Marshall campus, in Lancaster, Pa. Dr. Sax presented the Sigma Xi lecture at the University of Florida and, in returning to Jamaica Plain, lectured at the University of North Carolina, the Blandy Experimental Farm and Florida State University. He also presented by invitation a talk at the meeting of the Association of Southeastern Biologists in Knoxville, Tenn. Dr. Howard was a speaker at the 13th Annual Garden Symposium held at Williamsburg, Va. He attended the annual meeting of the American Institute of Biological Sciences where his paper on the anatomy of the petiole as a taxonomic character was awarded the George R. Cooley prize for the best paper presented to the section on plant taxonomy. Dr. Howard presented a paper on the same subject at the meeting of the northeastern section of the American Society of Horticultural Sciences. Dr. Wagenknecht spoke on the rules of horticultural nomenclature at the same meeting. Mr. Fordham attended the annual meetings of the Plant Propagators Society held in Cleveland, Ohio, and spoke on soft-wood cuttings to the horticultural chairmen of the Garden Club Federation of Massachusetts. Dr. Wyman was the principal speaker at the dedication exercises of the Minnesota Landscape Arboretum at St. Paul, Minnesota, and, with Mrs. Wyman, presented a program on Christmas decorations, plants and plant materials for the Garden Club Federation of Massachusetts. Mrs. Weber participated in the field trip of the American Society of Plant Taxonomists through eastern Kentucky in late August and then attended the meeting of the American Institute of Biological Sciences at Indiana University. Dr. Kobuski attended the Symposium on the Taxonomic Consequences of Man's Activities held by the Missouri Botanical Garden on October 24–25. Dr. Wood and Dr. Wilson attended the meeting of the Association of Southeastern Biologists, in Knoxville, Tennessee, in the course of their spring collecting trip.

Nearly all staff members were called upon as speakers for horticultural programs of gardens clubs in the five New England States.

Exhibits and Displays:

The Arboretum exhibit at the Spring Flower Show of the Massachusetts Horticultural Society by request featured the Larz Anderson collection of Japanese dwarfed trees. These trees, normally housed near the Arboretum greenhouses, were forced into leaf and flower for the March show. Because of the razing of Mechanics Building, the Spring Flower Show was held in Horticultural Hall and Symphony Hall. Unfortunately, a much smaller space than usual was available for our exhibit and the plants could not be shown to their best advantage. Nevertheless, the exhibit set up under the direction of Dr. Wyman, Mr. Williams and Mr. Fordham was awarded a first prize, a cultural certificate and a ribbon from the Massachusetts Department of Agriculture.



The Arnold Arboretum exhibit of *Bonsai* at the Spring Flower Show of the Massachusetts Horticultural Society.

The Christmas show of broad-leaved evergreens, Christmas plants and decorations was held in the lecture hall of the Administration Building. The Christmas tree decorated with native fruits, the wreath-making display prepared by Mrs. Wyman and the information on Christmas trees around the world compiled by Dr. Wagenknecht proved to be of interest to the visitors.

A special exhibit of recommended trees and shrubs for permanent and unusual plantings was prepared for the New England zone meeting of the Garden Club of America held at Cohasset. The New England sources of exhibited plants supplied by the staff proved to be of real interest. Apparently, many people feel that the plants seen at the Arboretum are not

readily available. Information on commercial sources of specific plants in the Arboretum collection is supplied by the staff at any time. Where possible, several commercial nurseries are suggested with selection being made only in consideration that a nearby nursery will encourage the prospective buyer more than the information that a mail order is necessary.

Library:

Following the completion of work on combining the library facilities mentioned in the last annual report, the activities of the library and its staff fell into more normal patterns of work. The library of the Arnold Arboretum is one of the outstanding botanical research libraries in the country. When considered in conjunction with the books comprising the library of the Gray Herbarium, the libraries are unsurpassed in quality for taxonomic and horticultural research. The library staff continued the work of reclassifying the extensive pamphlet collection, elaboration of the card index and a reconditioning of many of the books. The service offered to students, staff and visiting scholars was outstanding.

During the year 311 volumes were added to the library by purchase, exchange, transfer or binding, bringing the total volumes on hand to 50,515. Of the additions, 57 volumes were significant to horticultural research and were housed in Jamaica Plain. Several sets of periodicals considered more useful to horticultural work were transferred to the horticultural library. The pamphlet collection was improved and 462 items were added which, with some discarding of duplicates or unwanted materials, brought the pamphlet collection to a total of 16,984 items.

The Gray Herbarium Index to American Plants, maintained in Jamaica Plain, received 3000 new entry cards during the year. About 1200 new entry cards were added to the main index to aid in cross references. Services to other libraries and scientists included the dispatch of 198 books on inter-library loan.

Herbarium:

The work of combining the non-horticultural herbarium specimens of the Arnold Arboretum with the specimens of the Gray Herbarium was completed during the year. The progress and procedure of this major herbarium reorganization has been noted in the annual reports of the past five years. It is with gratitude that I acknowledge the energy and devotion of the Curator, Dr. C. E. Kobuski, who carried the responsibility for this task, and the contribution of the staff members who completed this major task in so short a time. The staff may now return to individual research programs with routine duties maintaining the excellent condition of the herbarium research facility.

During the year 5,918 specimens were mounted and added to the herbarium, bringing the total to 705,370 sheets. Considerable effort is made to repair damaged sheets as they are encountered, and 2,381 such sheets were reconditioned by the mounters.

Our records indicate that 16,581 specimens were received during the past

year. Of the total, 15,260 were in exchange, 3,246 as gifts, 339 for identification and 264 by purchase. The largest single shipment, consisting of 5,020 specimens from many parts of Russia, was received from the Academy of Sciences of the USSR. One of the most valuable collections was received by special arrangement from the Museum of Science in the Philippines through Dr. Eduardo Quisumbing. This collection consisted of 2,528 specimens made by the Spanish botanist Vidal in the Philippines between 1872 and 1890. Vidal's collections remained unstudied at the Museum de Ultramarino, in Madrid. During the past year Dr. Quisumbing, while on a Guggenheim Foundation grant, received permission to divide the Vidal collection, in return for its identification. Dr. Quisumbing felt that the most important location for this significant collection was in the Herbarium of the Arnold Arboretum, to supplement what probably is now the most important study collection of Philippine flora. Dr. Quisumbing spent six months of his Guggenheim Fellowship studying our collections from the Philippine archipelago.

The staff filled requests for 90 loans, totaling 13,855 specimens, from the combined herbaria to 46 different institutions, 33 in the United States and 13 in other countries. Sixty-eight loans numbering 10,272 specimens were requested from 44 institutions, 33 American and 10 foreign, for the use of staff members and students. It is interesting to note that incoming loans averaged 151 specimens and loans sent out on request averaged 154 specimens.

With the completion of our major effort in Cambridge, attention was turned to the horticultural herbarium in Jamaica Plain. Portions of the herbarium were painted, new fluorescent lighting was installed, and the entire herbarium was shifted to allow room for expansion. The addition of specimens of cultivated plants is included in the figure given above.

The significant taxonomic work of Rehder, Sargent, Palmer and others in the field of horticultural plant taxonomy antedated the current international rules of botanical and horticultural nomenclature. In anticipation of developing taxonomic work it is necessary to reconsider the work of these earlier Arboretum staff members. In many cases type specimens were not selected or, if selected, were not indicated as such in the original publication of the taxon. Staff members are proceeding to examine the specimens studied by these workers, to separate the types and to indicate lectotypes when necessary. Much of the work of Rehder and Sargent was based on plants growing in the living collections of the Arnold Arboretum. Such plants often were grown from seed collected in the wild at the same time as the herbarium specimen which is the type of a horticultural taxon. In other instances, the type of a horticultural taxon came from a living plant on our grounds. It is desirable to indicate the living plants which are either filial-types (progeny of the type collection) or living holotypes. Age, hurricanes and landscaping changes have destroyed many of these types in the past two decades. Labeling the survivors properly will enable us to preserve such specimens in future emergency situations, to propagate them and make such important specimens available to other arboreta.

The Rehder Index of horticultural nomenclature has been brought up to date and is being maintained current with the literature.

Comparative Morphology:

Professor I. W. Bailey, Professor of Plant Anatomy, *Emeritus*, continued to serve as curator of the wood collection of the Arnold Arboretum. His care of the collection, including filling requests for wood samples, is greatly appreciated. Professor Bailey has initiated an investigation of the anatomy of the Cactaceae under a three-year grant from the National Science Foundation. He is concentrating first on a comprehensive study of *Pereskia* and *Pereskiopsis*. The trees, large shrubs and vines that comprise these genera not only have a more normal dicotyledonous habit of growth than most cacti, but also have leaves and well-developed cotyledons. They are generally considered to be the most primitive living representatives of the cactus family. Thus they afford clues regarding the significance of morphological and physiological changes that occur during salient phylogenetic trends of specialization within the highly succulent and xerophytic tribes, *Opuntieae* and *Cereeae*.

Professor Bailey is also studying the structure and chemical composition of the intine of gymnospermous and angiospermous pollen under an assisting grant from the American Philosophical Society.

Cytogenetics:

Dr. Karl Sax has reported the following information on his work in the field of cytogenetics during the past year:

Some of the hybrids of the *Pinus* species made several decades ago are now producing male flowers. Cytological studies of meiosis in F_1 hybrids between *Pinus griffithii* and *P. strobus*, between *P. parviflora* and *P. strobus*, and other hybrids between Old and New World white pine species show almost normal chromosome pairing and a high degree of fertility. The fact that these hybrids are relatively fertile even though the parental species have been separated geographically for very long periods of time indicates that the species of pine have undergone little cytological change in recent evolution.

An induced tetraploid of *Forsythia* called 'Arnold Giant' has been used in breeding work to produce triploids. One of several dozen progeny of this tetraploid *Forsythia* proved to be relatively fertile, although triploids are usually highly sterile. A study of the fertile segregate showed it to be a tetraploid. Since there was only the one tetraploid clone in the Arnold Arboretum at that time the tetraploid progeny must have resulted from self pollination, although diploid forsythias are heterostylic and self-sterile. Apparently tetraploidy induced some degree of self-fertility in the short-styled *Forsythia* 'Arnold Giant.'

The *Forsythia* 'Arnold Dwarf' is a good ground cover, but it is slow in flowering and the flowers are of poor quality. Segregates are being grown to produce types with the fine foliage and spreading habit but with good flowers.

Breeding experiments with two outstanding ornamental crab apple varieties, 'Dorothea' and 'Katherine,' have resulted in several very desirable segregates which have been propagated for further testing.

While at the University of Florida, Dr. Sax applied the methods used on dwarfing fruit trees to grafted pine trees for the establishment of "Seed Orchards." If the techniques induce pines to produce seed at an earlier age and, therefore, smaller size, it would facilitate both spraying and harvesting of the cones.

Instruction:

Staff members were scheduled to offer three classes in the Department of Biology during the past year. During the fall term Dr. Sax presented his class on cytotaxonomy and, in the spring semester, Dr. Howard taught the principles and practice of horticultural plant taxonomy. Dr. Wagenknecht assisted Dr. Howard. During his leave-of-absence as visiting professor at the University of Florida, Dr. Sax offered a course in horticultural and cytological problems for the Department of Botany at Gainesville. Dr. Johnston's class in advanced plant taxonomy was not given.

A series of luncheon seminars presented for staff and graduate students considered the problems of plant distribution and centers of origin. In addition to regular programs presented by the staff members, visiting colleagues, including Dr. Eduardo Quisumbing, of the Philippines, Dr. R. D. Hoogland, of New Guinea, and Dr. André Kostermans, of Indonesia, spoke on plant science in their respective areas of the world.

Travel and Exploration:

Dr. Carroll Wood and Dr. Kenneth Wilson completed a month-long, 4,000-mile collecting trip involving field studies for their work on the flora of the southeastern states. They visited areas in Tennessee, Alabama, Florida, Georgia and North and South Carolina. A number of living collections in the genera *Liriodendron*, *Calycanthus*, *Philadelphus*, *Malus*, *Amelanchier*, *Robinia*, *Lonicera* and *Diervilla*, mostly from northeastern Alabama, were sent to the Arboretum for trials. All of these were wild clones of recognized ornamental genera worthy of cultivation. It is apparent that the area is worthy of more detailed collection and selection, for, in the past, it has yielded such ornamental plants as *Oxydendrum*, *Halesia*, *Liriodendron*, *Cladrastis*, *Catalpa*, *Fothergilla* and several deciduous rhododendrons.

During the spring, Dr. Donald Wyman visited azalea collections in Virginia and adjacent states to continue his studies and selections of ornamental subjects in this important group. Dr. Ivan Johnston collected in Texas and Mexico during the year, and Dr. Richard Howard continued his studies of vegetation on bauxite soils in Hawaii. Dr. Frances Jarrett spent a month in England studying the Moraceae in the herbaria of the Royal Botanic Gardens, at Kew, the British Museum (Natural History), and the Botany School, Cambridge University.

Gifts and Grants:

Again this spring the "Friends of the Arnold Arboretum" were generous in their response to the annual appeal for gifts to support the horticultural work of the Arboretum. The financial support obtained is used to supply assistants in the work of plant propagation and for additional labor on the grounds during the summer months. A special gift was received from the Godfrey Cabot Charitable Trust to install an acoustic tile ceiling in the lecture hall of the Administration Building. It is expected that this work will be completed during the summer and will make the auditorium a more pleasant place for meetings.

Special gifts or grants from individuals and foundations were received to support the research work of various staff members. A gift from Mr. George R. Cooley will support the work of Dr. Carroll E. Wood and Dr. Kenneth Wilson on the flora of the southeastern United States. Dr. Karl Sax received a continuation of his grant from the Massachusetts Society for Promoting Agriculture for work on dwarf rootstocks and for methods of promoting the growth and fruiting of fruit trees for New England. The award of a Guggenheim Fellowship to Dr. Sax for work in Oxford, England, after his retirement, has already been announced. Professor I. W. Bailey has received a grant from the National Science Foundation to aid his investigation of the anatomy of the leafy cacti, *Pereskia* and *Pereskiopsis*. Dr. Richard Howard was also awarded a second National Science Foundation grant for work on the anatomy of the petiole as a taxonomic character in the flowering plants.

Publications:

The regular twelve issues of *Arnoldia*, under the editorship of Dr. Donald Wyman, and the four issues of the *Journal of the Arnold Arboretum*, edited by Dr. Carroll Wood, were published during the year. In addition, two special publications were sponsored by the Arboretum. The important pamphlet, "Abbreviations of Titles of Serials Cited by Botanists," compiled by Mrs. Lazella Schwarten and Dr. Harold Rickett and issued first in the *Bulletin of the Torrey Botanical Club*, proved invaluable to botanists. The original supply of reprints was quickly exhausted and the pamphlet was reprinted. A new edition of "The Arboretums and Botanical Gardens of North America" was compiled by Dr. Wyman and issued by the Arnold Arboretum as a special publication. This work was originally published as an issue of *Chronica Botanica* in 1947. More up-to-date information was obtained by questionnaire and the new edition was issued in May, 1959.

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RICHARD A. HOWARD, *Director*

Staff of the Arnold Arboretum

1958–1959

Richard Alden Howard, Ph.D., Arnold Professor of Botany, Professor of Dendrology, and Director.

Irving Widmer Bailey, S.D., Professor of Plant Anatomy, *Emeritus*.

Joseph Horace Faull, Ph.D., Professor of Forest Pathology, *Emeritus*.

Michael Anthony Canoso, M.S., Curatorial Assistant.*

Alfred James Fordham, Propagator.

Heman Arthur Howard, Assistant Horticulturist.

Shiu-ying Hu, Ph.D., Botanist.

Frances Mary Jarrett, Ph.D., Botanist.

Ivan Murray Johnston, Ph.D., Associate Professor of Botany.

Clarence Emmeren Kobuski, Ph.D., Curator.*

Margaret Catherine Lefavour, Herbarium Secretary.

Mary Scanlan Lehmer, Ed.M., Business Secretary.

Susan Delano McKelvey, A.B., Research Associate.

Lily May Perry, Ph.D., Botanist.

Karl Sax, S.D., Professor of Botany.

Lazella Schwarten, Librarian.*

Burdette Lewis Wagenknecht, Ph.D., Horticultural Taxonomist.

Claude Weber, Botanist, Special Project.*

Kenneth Allen Wilson, Ph.D., Botanist, Southeastern Flora Project.*

Robert Gerow Williams, B.S., Superintendent.

Carroll Emory Wood, Jr., Ph.D., Associate Curator and Editor.

Donald Wyman, Ph.D., Horticulturist.

* Appointed jointly with the Gray Herbarium.

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